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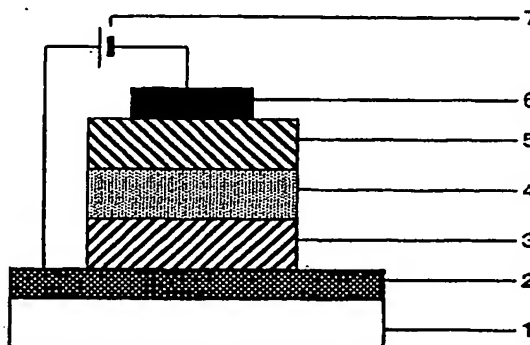
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(54) **HYDROCARBON COMPOUND, MATERIAL FOR ORGANIC ELECTROLUMINESCENT ELEMENT AND ORGANIC ELECTROLUMINESCENT ELEMENT**

(57) An electroluminescent element in which at least one layer containing at least one of novel hydrocarbon compounds with an anthracene ring and a fluorene ring directly bound is held between a pair of electrodes. The

compounds can advantageously be used in a luminescent element and provide an organic electroluminescent element having an excellent luminescent efficiency and a long luminescent life.

Figure 1



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Description

Technical Field

[0001] The present invention relates to organic electroluminescent elements, materials for organic electroluminescent elements which can advantageously be used in the luminescent elements and novel hydrocarbon compounds.

Background of the Invention

[0002] Inorganic electroluminescent elements have been so far used as, for example, panel-type light sources of back light and the like. However, a high AC voltage is required to drive the luminescent elements. Recently, organic electroluminescent elements (organic EL elements) using organic materials as luminescent materials have been developed [Appl. Phys. Lett., 51, 913 (1987)]. The organic electroluminescent element is an element having a structure that a thin film containing a compound having a luminescent performance is held between an anode and a cathode, in which electrons and holes are injected in the thin film for recombination to generate excitons and luminescence occurs using light released in deactivating the excitons. The organic electroluminescent element enables luminescence at a low DC voltage of several volts to several tens of volts. Further, luminescence of various colors (for example, red, blue and green) is possible by selecting types of fluorescent organic compounds. The organic electroluminescent element having such characteristics is expected to be applied to various luminescent elements, display devices and the like. However, a luminescent brightness is generally low, which is unsatisfactory in practice.

[0003] As a method for improving a luminescent brightness, an organic electroluminescent element using, for example, tris(8-quinolinolato)aluminum as a host compound and coumalin derivatives or pyran derivatives as a guest compound (dopant) in a luminescent layer is proposed [J. Appl. Phys., 65, 3610 (1989)]. Further, an organic electroluminescent element using anthracene derivatives as a material of a luminescent layer is proposed (Japanese Patent Laid-Open Nos. 12,600/1996 and 111,458/1999). Still further, an organic electroluminescent element using anthracene derivatives as a guest compound of a luminescent layer is proposed (Japanese Patent Laid-Open Nos. 36,832/1998 and 294,179/1998).

[0004] However, these luminescent elements are not said either to have a satisfactory luminescent brightness and a satisfactory luminescent life.

[0005] Organic electroluminescent elements that allow luminescence with a higher luminescent brightness and a longer life have been currently in demand.

Disclosure of the Invention

[0006] The invention aims to provide an organic electroluminescent element which is excellent in luminescent efficiency and allows luminescence with a high brightness and a long life. Further, it aims to provide materials for an organic electroluminescent element which can advantageously be used in the luminescent element. Still further, it aims to provide novel hydrocarbon compounds.

[0007] The present inventors have assiduously conducted investigations on organic electroluminescent elements, and have consequently come to complete the invention.

[0008] That is, the invention relates to

- (1) hydrocarbon compounds in which an anthracene ring and a fluorene ring are directly bound,
- (2) the hydrocarbon compounds as recited in 1, wherein the fluorene ring is bound in the position except the 9-position,
- (3) hydrocarbon compounds represented by the formula (1)



wherein A_1 and A_2 , independently from each other, represent a substituted or unsubstituted anthracen-diyl group, F_1 , F_2 and F_3 , independently from each other, represent a substituted or unsubstituted fluoren-diyl group, X_1 and X_2 , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, j , m and n represent 0 or 1, k and 1 represent 1 or 2, when k is 2 A_1 's may be the same or different, and when 1 is 2 F_2 's may be the same or different, (4) the hydrocarbon compounds as recited in 3, wherein k is 1,

(5) the hydrocarbon compounds as recited in 4, wherein A_1 and A_2 are an anthracen-9,10-diyl group, and F_1 , F_2 and F_3 are a fluoren-2,7-diyl group,

(6) the hydrocarbon compounds as recited in 3, wherein j and n are 0, 1 is 1, and $k + m$ is 2,

(7) the hydrocarbon compounds as recited in 6, wherein A_1 and A_2 are an anthracen-9,10-diyl group, and F_2 is a fluoren-2,7-diyl group,

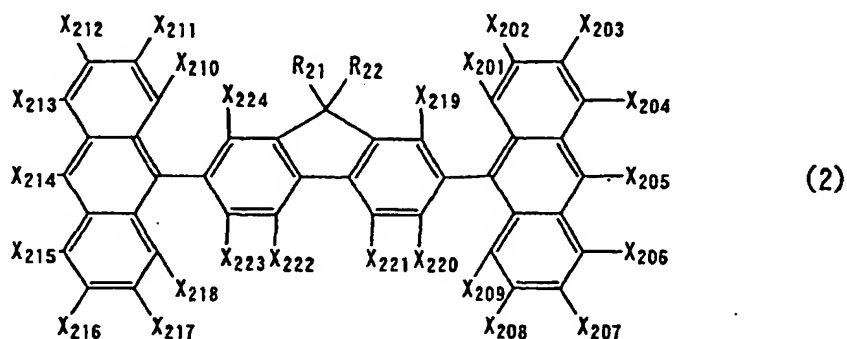
(8) the hydrocarbon compounds as recited in 3, wherein $j + 1 + n$ is 2, k is 1, and m is 0,

(9) the hydrocarbon compounds as recited in 8, wherein A_1 is an anthracen-9,10-diyl group, and F_1 , F_2 and F_3 are a fluoren-2,7-diyl group,

(10) the hydrocarbon compounds as recited in 3, wherein j , m and n are 0, and k and 1 are 1,

(11) the hydrocarbon compounds as recited in 10, wherein A_1 is an anthracen-9,10-diyl group, and F_2 is a fluoren-2,7-diyl group,

(12) hydrocarbon compounds represented by the formula (2)



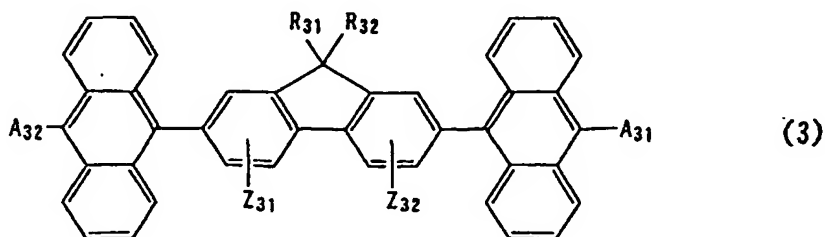
wherein R_{21} and R_{22} , independently from each other, represent a hydrogen atom, a linear, branched or cyclic alkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, and X_{201} to X_{214} , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, or a substituted or unsubstituted aryl group, provided R_{21} , R_{22} and X_{201} to X_{224} are not an anthryl group or a fluorenyl group,

(13) the hydrocarbon compounds as recited in 12, wherein X_{205} and X_{214} are a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, or a substituted or unsubstituted aryl group,

(14) the hydrocarbon compounds as recited in 12, wherein X_{205} and X_{214} are a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, or a substituted or unsubstituted heterocyclic aromatic group,

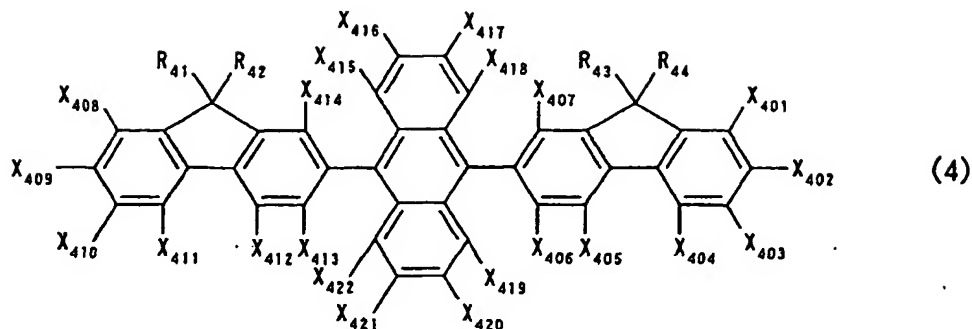
(15) the hydrocarbon compounds as recited in 12, wherein X_{201} , X_{204} , X_{206} , X_{209} , X_{210} , X_{213} , X_{215} and X_{218} are a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, or a linear, branched or cyclic alkoxy group,

(16) hydrocarbon compounds represented by the formula (3)



wherein R_{31} and R_{32} , independently from each other, represent a hydrogen atom, a linear, branched or cyclic alkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, A_{31} and A_{32} , independently from each other, represent a substituted or unsubstituted aryl group, and Z_{31} and Z_{32} , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, or a substituted or unsubstituted aryl group,

(17) hydrocarbon compounds represented by the formula (4)

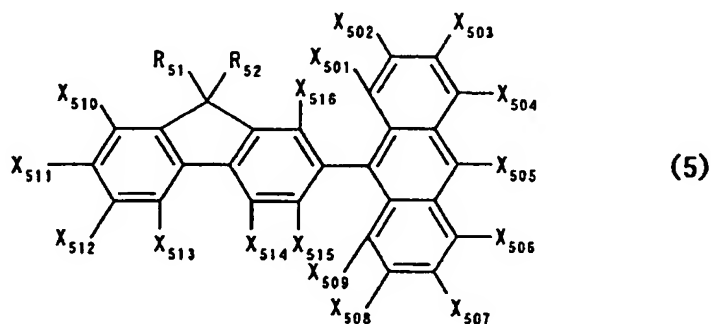


15 wherein R_{41} to R_{44} , independently from each other, represent a hydrogen atom, a linear, branched or cyclic alkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, and X_{401} to X_{422} , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, or a substituted or unsubstituted aryl group, provided R_{41} to R_{44} and X_{401} to X_{422} are not an anthryl group or a fluorenyl group,

20 (18) the hydrocarbon compounds as recited in 17,

wherein X_{415} , X_{418} , X_{419} and X_{422} are a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, or a linear, branched or cyclic alkoxy group,

(19) hydrocarbon compounds represented by the formula (5)

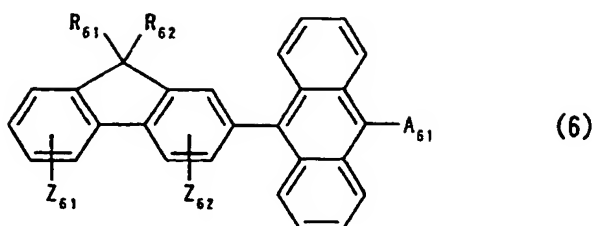


40 wherein R_{51} and R_{52} , independently from each other, represent a hydrogen atom, a linear, branched or cyclic alkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, and X_{501} to X_{516} , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, or a substituted or unsubstituted aryl group, provided R_{51} , R_{52} and X_{501} to X_{516} are not an anthryl group or a fluorenyl group,

45 (20) the hydrocarbon compounds as recited in 19, wherein X_{505} is a halogen atom, a linear, branched or cyclic alkyl group, or a substituted or unsubstituted aryl group,

(21) the hydrocarbon compounds as recited in 19, wherein X_{501} , X_{504} , X_{506} and X_{509} are a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, or a linear, branched or cyclic alkoxy group,

(22) hydrocarbon compounds represented by the formula (6)



wherein R_{61} and R_{62} , independently from each other, represent a hydrogen atom, a linear, branched or cyclic alkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, A_{61} represents a substituted or unsubstituted aryl group, and Z_{61} and Z_{62} , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, or a substituted or unsubstituted aryl group,

(23) materials for an organic electroluminescent element as recited in any one of 1 to 22,

(24) an organic electroluminescent element in which at least one layer containing at least one of the materials for the organic electroluminescent element as recited in 23 is held between a pair of electrodes,

(25) the organic electroluminescent element as recited in 24, wherein the layer containing the material for the organic electroluminescent element as recited in 23 is a luminescent layer,

(26) the organic electroluminescent element as recited in 24 or 25, wherein the layer containing the material for the organic electroluminescent element as recited in 23 further contains a luminescent organic metal complex,

(27) the organic electroluminescent element as recited in 24 or 25, wherein the layer containing the material for the organic electroluminescent element as recited in 23 further contains triarylamine derivatives,

(28) the organic electroluminescent element as recited in any one of 24 to 27, wherein a hole injection transport layer is further provided between a pair of electrodes, and

(29) the organic electroluminescent element as recited in any one of 24 to 28, wherein an electron injection transport layer is further provided between a pair of electrodes.

Brief Description of the Drawings

[0009]

Figs. 1 to 8 are each a schematic view showing a structure of an organic electroluminescent element.

Fig. 1 is (A) an anode/hole injection transport layer/luminescent layer/electron injection transport layer/cathode-type element;

Fig. 2 is (B) an anode/hole injection transport layer/luminescent layer/cathode-type element;

Fig. 3 is (C) an anode/luminescent layer/electron injection transport layer/cathode-type element;

Fig. 4 is (D) an anode/luminescent layer/cathode-type element; further,

Fig. 5 is (E) an anode/hole injection transport layer/electron injection transport layer/luminescent layer/electron injection transport layer/cathode-type element which is an element of a type with a luminescent layer held between electron injection transport layers;

Fig. 6 is, while the structure of the (D)-type element includes an element of a type in which the luminescent component in the form of one layer is held between the pair of electrodes, for example, (F) an element of a type in which a combination of a hole injection transport component, a luminescent component and an electron injection transport component in the form of one layer is held between a pair of electrodes;

Fig. 7 is (G) an element of a type in which a combination of a hole injection transport component and a luminescent component in the form of one layer is held between a pair of electrodes; and

Fig. 8 is (H) an element of a type in which a combination of a luminescent component and an electron injection transport component in the form of one layer is held between a pair of electrodes.

[0010] In these drawings, the numerals are as follows.

- 1 : substrate
- 2 : anode
- 3 : hole injection transport layer
- 3a : hole injection transport component

- 4 : luminescent layer
- 4a : luminescent component
- 5 : electron injection transport layer
- 5' : electron injection transport layer
- 5a : electron injection transport component
- 6 : cathode
- 7 : power supply

Best Mode for Carrying Out the Invention

[0011] The invention is described in detail below.

[0012] The invention relates to hydrocarbon compounds in which an anthracene ring and a fluorene ring are directly bound.

[0013] The hydrocarbon compounds in which the anthracene ring and the fluorene ring are directly bound according to the invention (hereinafter abbreviated as compounds A according to the invention) do not include polymers, and are preferably compounds having a molecular weight of 2,000 or less, more preferably compounds having a molecular weight of 1,000 or less.

[0014] Compounds A according to the invention are preferably compounds in which the fluorene ring is bound to the anthracene ring in the position except the 9-position, more preferably compounds represented by the formula (1)



wherein A_1 and A_2 , independently from each other, represent a substituted or unsubstituted anthracen-diyl group, F_1 , F_2 and F_3 , independently from each other, represent a substituted or unsubstituted fluoren-diyl group, X_1 and X_2 , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, j , m and n represent 0 or 1, k and 1 represent 1 or 2, when k is 2 A_1 's may be the same or different, and when 1 is 2 F_2 's may be the same or different.

[0015] In the compounds represented by the formula (1), X_1 and X_2 , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group.

[0016] Incidentally, the aryl group refers to carbocyclic aromatic groups such as a phenyl group, a naphthyl group and the like, and heterocyclic aromatic groups such as a furfuryl group, a thienyl group, a pyridyl group and the like.

[0017] Further, in the compounds represented by the formula (1), the amino group of X_1 and X_2 may have a substituent, and may be mono-substituted or di-substituted with a substituent such as an alkyl group having 1 to 20 carbon atoms, an aryl group having 3 to 20 carbon atoms, an aralkyl group having 4 to 20 carbon atoms or the like.

[0018] Moreover, in the compounds represented by the formula (1), the aryl group and the aralkyl group of X_1 and X_2 may have a substituent, and may be mono-substituted or polysubstituted with a substituent such as a halogen atom, a linear, branched or cyclic alkyl group having 1 to 16 carbon atoms, a linear, branched or cyclic alkoxy group having 1 to 16 carbon atoms, an N-mono-substituted amino group having 1 to 20 carbon atoms, an N,N-di-substituted amino group having 2 to 40 carbon atoms, an aryl group having 3 to 25 carbon atoms, an aralkyl group having 5 to 16 carbon atoms or the like.

[0019] X_1 and X_2 are preferably a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group having 1 to 16 carbon atoms, a linear, branched or cyclic alkoxy group having 1 to 16 carbon atoms, an unsubstituted amino group, a substituted amino group having 1 to 24 carbon atoms, a substituted or unsubstituted carbocyclic aromatic group having 6 to 25 carbon atoms, a substituted or unsubstituted heterocyclic aromatic group having 3 to 25 carbon atoms, or a substituted or unsubstituted aralkyl group having 5 to 16 carbon atoms, more preferably a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group having 1 to 10 carbon atoms, a linear, branched or cyclic alkoxy group having 1 to 10 carbon atoms, a substituted amino group having 1 to 20 carbon atoms, a substituted or unsubstituted carbocyclic aromatic group having 6 to 12 carbon atoms, a substituted or unsubstituted heterocyclic aromatic group having 4 to 12 carbon atoms, or a substituted or unsubstituted aralkyl group having 7 to 12 carbon atoms, further preferably a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group having 1 to 8 carbon atoms, a substituted amino group having 2 to 20 carbon atoms, a substituted or unsubstituted carbocyclic aromatic group having 6 to 10 carbon atoms, a substituted or unsubstituted heterocyclic aromatic group having 4 to 10 carbon atoms, or a substituted or unsubstituted aralkyl group having

7 to 10 carbon atoms.

[0020] Specific examples of X_1 and X_2 include a hydrogen atom; halogen atoms such as a fluorine atom, a chlorine atom, a bromine atom and the like;

linear, branched or cyclic alkyl groups such as a methyl group, an ethyl group, an n-propyl group, an isopropyl group, an n-butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, an n-pentyl group, an isopentyl group, a neopentyl group, a tert-pentyl group, a cyclopentyl group, an n-hexyl group, a 1-methylpentyl group, a 4-methyl-2-pentyl group, a 3,3-dimethylbutyl group, a 2-ethylbutyl group, a cyclohexyl group, an n-heptyl group, a 1-methylhexyl group, a cyclohexylmethyl group, a 4-tert-butylcyclohexyl group, an n-heptyl group, a cycloheptyl group, an n-octyl group, a cyclooctyl group, a tert-octyl group, a 1-methylheptyl group, a 2-ethylhexyl group, a 2-propylpentyl group, an n-nonyl group, a 2,2-dimethylheptyl group, a 2,6-dimethyl-4-heptyl group, a 3,5,5-trimethylhexyl group, an n-decyl group, an n-undecyl group, a 1-methyldecyl group, an n-dodecyl group, an n-tridecyl group, a 1-hexylheptyl group, an n-tetradecyl group, an n-pentadecyl group, an n-hexadecyl group, an n-heptadecyl group, an n-octadecyl group, an n-eicosyl group and the like; a linear, branched or cyclic alkoxy group such as a methoxy group, an ethoxy group, an n-propoxy group, an isopropoxy group, an n-butoxy group, an isobutoxy group, a sec-butoxy group, an n-pentyloxy group, a neopentyloxy group, a cyclopentyloxy group, an n-hexyloxy group, a 3,3-dimethylbutoxy group, a 2-ethylbutoxy group, a cyclohexyloxy group, an n-heptyloxy group, an n-octyloxy group, a 2-ethylhexyloxy group, an n-nonyloxy group, an n-decyloxy group, an n-undecyloxy group, an n-dodecyloxy group, an n-tridecyloxy group, an n-tetradecyloxy group, an n-pentadecyloxy group, an n-hexadecyloxy group, an n-heptadecyloxy group, an n-octadecyloxy group, an n-eicosyloxy group and the like;

substituted or unsubstituted amino groups such as an amino group, an N-methylamino group, an N-ethylamino group, an N-n-butylamino group, an N-cyclohexylamino group, an N-n-octylamino group, an N-n-decylamino group, an N-benzylamino group, an N-phenylamino group, an N-(3-methylphenyl)amino group, an N-(4-methylphenyl)amino group, an N-(4-n-butylphenyl)amino group, an N-(4-methoxyphenyl)amino group, an N-(3-fluorophenyl)amino group, an N-(4-chlorophenyl)amino group, an N-(1-naphthyl)amino group, an N-(2-naphthyl)amino group, an N,N-dimethylamino group, an N,N-diethylamino group, an N,N-di-n-butylamino group, an N,N-di-n-hexylamino group, an N,N-di-n-octylamino group, an N,N-di-n-decylamino group, an N,N-di-n-dodecylamino group, an N-methyl-N-ethylamino group, an N-ethyl-N-n-butylamino group, an N-methyl-N-phenylamino group, an N-n-butyl-N-phenylamino group, an N,N-diphenylamino group, an N,N-di(3-methylphenyl)amino group, an N,N-di(4-methylphenyl)amino group, an N,N-di(4-ethylphenyl)amino group,

an N,N-di(4-tert-butylphenyl)amino group, an N,N-di(4-n-hexylphenyl)amino group, an N,N-di(4-methoxyphenyl)amino group, an N,N-di(4-ethoxyphenyl)amino group, an N,N-di(4-n-butyloxyphenyl)amino group, an N,N-di(4-n-hexyloxyphenyl)amino group, an N,N-di(1-naphthyl)amino group, an N,N-di(2-naphthyl)amino group, an N-phenyl-N-(3-methylphenyl)amino group, an N-phenyl-N-(4-methylphenyl)amino group, an N-phenyl-N-(4-octylphenyl)amino group, an N-phenyl-N-(4-methoxyphenyl)amino group, an N-phenyl-N-(4-ethoxyphenyl)amino group, an N-phenyl-N-(4-n-hexyloxyphenyl)amino group, an N-phenyl-N-(4-fluorophenyl)amino group, an N-phenyl-N-(1-naphthyl)amino group, an N-phenyl-N-(2-naphthyl)amino group, an N-phenyl-N-(4-phenylphenyl)amino group and the like; substituted or unsubstituted carbocyclic aromatic groups such as a phenyl group, a 4-methylphenyl group, a 3-methylphenyl group, a 2-methylphenyl group, a 4-ethylphenyl group, a 3-ethylphenyl group, a 2-ethylphenyl group, a 4-n-propylphenyl group, a 4-isopropylphenyl group, a 2-isopropylphenyl group, a 4-n-butylphenyl group, a 4-isobutylphenyl group, a 4-sec-butylphenyl group, a 2-sec-butylphenyl group, a 4-tert-butylphenyl group, a 3-tert-butylphenyl group, a 2-tert-butylphenyl group, a 4-n-pentylphenyl group, a 4-isopentylphenyl group, a 4-neopentylphenyl group, a 4-tert-pentylphenyl group, a 4-n-hexylphenyl group, a 4-(2'-ethylbutyl)phenyl group, a 4-n-heptylphenyl group, a 4-n-octylphenyl group, a 4-(2'-ethylhexyl)phenyl group, a 4-n-nonylphenyl group, a 4-n-decylphenyl group, a 4-n-undecylphenyl group, a 4-n-dodecylphenyl group, a 4-n-tetradecylphenyl group, a 4-cyclohexylphenyl group, a 4-(4'-methylcyclohexyl)phenyl group, a 4-(4'-tert-butylcyclohexyl)phenyl group, a 3-cyclohexylphenyl group, a 2-cyclohexylphenyl group, a 2,3-dimethylphenyl group, a 2,4-dimethylphenyl group, a 2,5-dimethylphenyl group, a 2,6-dimethylphenyl group, a 3,4-dimethylphenyl group, a 3,5-dimethylphenyl group, a 3,4,5-trimethylphenyl group, a 2,3,5,6-tetramethylphenyl group, a 2,4-diethylphenyl group, a 2,6-diethylphenyl group, a 2,5-diisopropylphenyl group, a 2,6-diisopropylphenyl group, a 2,6-diisobutylphenyl group, a 2,4-di-tert-butylphenyl group, a 2,5-di-tert-butylphenyl group, a 4,6-di-tert-butyl-2-methylphenyl group, a 5-tert-butyl-2-methylphenyl group, a 4-tert-butyl-2,6-dimethylphenyl group, a 1-naphthyl group, a 2-naphthyl group, a 1,2,3,4-tetrahydro-5-naphthyl group, a 1,2,3,4-tetrahydro-6-naphthyl group, a 4-ethyl-1-naphthyl group, a 6-n-butyl-2-naphthyl group, a 5-indanyl group, a 4-methoxyphenyl group, a 3-methoxyphenyl group, a 2-methoxyphenyl group, a 4-ethoxyphenyl group, a 3-ethoxyphenyl group, a 2-ethoxyphenyl group, a 4-n-propyloxyphenyl group, a 3-n-propyloxyphenyl group, a 4-isopropoxyphenyl group, a 2-isopropoxyphenyl group, a 4-n-butyloxyphenyl group, a 4-isobutyloxyphenyl group, a 2-sec-butyloxyphenyl group, a 4-n-pentyloxyphenyl group, a 4-isopentyloxyphenyl group, a 2-isopentyloxyphenyl group, a 4-neopentyloxyphenyl group, a 2-neopentyloxyphenyl group, a 4-n-hexyloxyphenyl group, a 4-(2'-ethylbutyl)oxyphenyl group, a 4-n-heptyloxyphenyl group, a 4-n-octyloxyphenyl group, a 4-n-nonyloxyphenyl group, a 4-n-decyloxyphenyl group, a 4-n-undecyloxyphenyl group, a 4-n-dodecyloxyphenyl group, a 4-n-tet-

radecyloxyphenyl group, a 4-cyclohexyloxyphenyl group, a 2-cyclohexyloxyphenyl group, a 2,3-dimethoxyphenyl group, a 2,4-dimethoxyphenyl group, a 2,5-dimethoxyphenyl group, a 3,4-dimethoxyphenyl group, a 3,5-dimethoxyphenyl group, a 3,5-diethoxyphenyl group, a 2-methoxy-4-methylphenyl group, a 2-methoxy-5-methylphenyl group, a 2-methyl-4-methoxyphenyl group, a 3-methyl-4-methoxyphenyl group, a 3-methyl-5-methoxyphenyl group, a 2-methoxy-1-naphthyl group, a 4-methoxy-1-naphthyl group, a 4-n-butyloxy-1-naphthyl group, a 5-ethoxy-1-naphthyl group, a 6-methoxy-2-naphthyl group, a 6-ethoxy-2-naphthyl group, a 6-n-butyloxy-2-naphthyl group, a 6-n-hexyloxy-2-naphthyl group, a 7-methoxy-2-naphthyl group, a 7-n-butyloxy-2-naphthyl group, a 4-phenylphenyl group, a 3-phenylphenyl group, a 2-phenylphenyl group, a 4-(4'-methylphenyl)phenyl group, a 4-(3'-methylphenyl)phenyl group, a 4-(4'-ethylphenyl)phenyl group, a 4-(4'-isopropylphenyl)phenyl group, a 4-(4'-tert-butylphenyl)phenyl group, a 4-(4'-n-hexylphenyl)phenyl group, a 4-(4'-n-octylphenyl)phenyl group, a 4-(4'-methoxyphenyl)phenyl group, a 4-(4'-n-butyloxyphenyl)phenyl group, a 2-(2'-methoxyphenyl)phenyl group, a 4-(4'-chlorophenyl)phenyl group, a 3-methyl-4-phenylphenyl group, a 3-methoxy-4-phenylphenyl group, a 9-phenyl-2-fluorenyl group, a 9,9-diphenyl-2-fluorenyl group, a 9-methyl-9-phenyl-2-fluorenyl group, a 9-ethyl-9-phenyl-2-fluorenyl group, a 4-fluorophenyl group, a 3-fluorophenyl group, a 2-fluorophenyl group, a 4-chlorophenyl group, a 3-chlorophenyl group, a 2-chlorophenyl group, a 4-bromophenyl group, a 2-bromophenyl group, a 4-trifluoromethylphenyl group, a 2,3-difluorophenyl group, a 2,4-difluorophenyl group, a 2,5-difluorophenyl group, a 2,6-difluorophenyl group, a 3,4-difluorophenyl group, a 3,5-difluorophenyl group, a 2,3-dichlorophenyl group, a 2,4-dichlorophenyl group, a 2,5-dichlorophenyl group, a 3,4-dichlorophenyl group, a 3,5-dichlorophenyl group, a 2,5-dibromophenyl group, a 2,4,6-trichlorophenyl group, a 2-fluoro-4-methylphenyl group, a 2-fluoro-5-methylphenyl group, a 3-fluoro-2-methylphenyl group, a 3-fluoro-4-methylphenyl group, a 2-methyl-4-fluorophenyl group, a 2-methyl-5-fluorophenyl group, a 3-methyl-4-fluorophenyl group, a 2-chloro-4-methylphenyl group, a 2-chloro-5-methylphenyl group, a 2-chloro-6-methylphenyl group, a 3-chloro-4-methylphenyl group, a 2-methyl-3-chlorophenyl group, a 2-methyl-4-chlorophenyl group, a 3-methyl-4-chlorophenyl group, a 2-chloro-4,6-dimethylphenyl group, a 2,4-dichloro-1-naphthyl group, a 1,6-dichloro-2-naphthyl group, a 2-methoxy-4-fluorophenyl group, a 3-methoxy-4-fluorophenyl group, a 2-fluoro-4-methoxyphenyl group, a 2-fluoro-4-ethoxyphenyl group, a 2-fluoro-6-methoxyphenyl group, a 3-fluoro-4-methoxyphenyl group, a 3-fluoro-4-ethoxyphenyl group, a 2-chloro-4-methoxyphenyl group, a 3-chloro-4-methoxyphenyl group, a 2-methoxy-5-chlorophenyl group, a 3-methoxy-4-chlorophenyl group, a 3-methoxy-6-chlorophenyl group, a 5-chloro-2,4-dimethoxyphenyl group and the like; and substituted or unsubstituted heterocyclic aromatic groups such as a 4-quinolyl group, a 3-quinolyl group, a 4-methyl-2-quinolyl group, a 4-pyridyl group, a 3-pyridyl group, a 2-pyridyl group, a 4-methyl-2-pyridyl group, a 5-methyl-2-pyridyl group, a 6-methyl-2-pyridyl group, a 6-fluoro-3-pyridyl group, a 6-methoxy-3-pyridyl group, a 6-methoxy-2-pyridyl group, a 3-furyl group, a 2-furyl group, a 3-thienyl group, a 2-thienyl group, a 4-methyl-3-thienyl group, a 5-methyl-2-thienyl group, a 3-methyl-2-thienyl group, a 2-oxazolyl group, a 2-thiazolyl group, a 2-benzoxazolyl group, a 2-benzothiazolyl group, a 2-benzimidazolyl group and the like; and substituted or unsubstituted aralkyl groups such as a benzyl group, a phenetyl group, an α -methylbenzyl group, an α,α -dimethylbenzyl group, a 1-naphthylmethyl group, a 2-naphthylmethyl group, a furfuryl group, a 2-methylbenzyl group, a 3-methylbenzyl group, a 4-methylbenzyl group, a 4-ethylbenzyl group, a 4-isopropylbenzyl group, a 4-tert-butylbenzyl group, a 4-n-hexylbenzyl group, a 4-n-nonylbenzyl group, a 3,4-dimethylbenzyl group, a 3-methoxybenzyl group, a 4-methoxybenzyl group, a 4-ethoxybenzyl group, a 4-n-butyloxybenzyl group, a 4-n-hexyloxybenzyl group, a 4-n-nonyloxybenzyl group, a 3-fluorobenzyl group, a 4-fluorobenzyl group, a 2-chlorobenzyl group, a 4-chlorobenzyl group and the like.

[0021] In the compounds represented by the formula (1), A_1 and A_2 , independently from each other, represent a substituted or unsubstituted anthracen-diyl group, and F_1 , F_2 and F_3 , independently from each other, represent a substituted or unsubstituted fluorene-diyl group.

[0022] Examples of the substituent when A_1 , A_2 , F_1 , F_2 and F_3 have a substituent include a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, a substituted or unsubstituted aryl group, and a substituted or unsubstituted aralkyl group.

[0023] Incidentally, the aryl group refers to carbocyclic aromatic groups such as a phenyl group, a naphthyl group and the like, and heterocyclic aromatic groups such as a furfuryl group, a thienyl group, a pyridyl group and the like.

[0024] Specific examples of the substituent when A_1 , A_2 , F_1 , F_2 and F_3 have a substituent can include a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, a substituted or unsubstituted carbocyclic aromatic group, a substituted or unsubstituted heterocyclic aromatic group, and a substituted or unsubstituted aralkyl group listed as specific examples of X_1 and X_2 .

[0025] Examples of A_1 and A_2 include

a substituted or unsubstituted anthracen-1,4-diyl group,
a substituted or unsubstituted anthracen-1,5-diyl group,
a substituted or unsubstituted anthracen-1,8-diyl group,
a substituted or unsubstituted anthracen-1,9-diyl group,
a substituted or unsubstituted anthracen-1,10-diyl group,
a substituted or unsubstituted anthracen-2,3-diyl group,

a substituted or unsubstituted anthracen-2,6-diyl group,
 a substituted or unsubstituted anthracen-2,7-diyl group,
 a substituted or unsubstituted anthracen-2,9-diyl group,
 a substituted or unsubstituted anthracen-2,10-diyl group,
 and a substituted or unsubstituted anthracen-9,10-diyl group.

[0026] Preferable are

a substituted or unsubstituted anthracen-1,4-diyl group,
 a substituted or unsubstituted anthracen-1,5-diyl group,
 a substituted or unsubstituted anthracen-2,6-diyl group,

a substituted or unsubstituted anthracen-2,7-diyl group, and a substituted or unsubstituted anthracen-9,10-diyl group.

[0027] More preferable is a substituted or unsubstituted anthracen-9,10-diyl group.

[0028] Examples of F_1 , F_2 and F_3 include

a substituted or unsubstituted fluoren-1,3-diyl group,
 a substituted or unsubstituted fluoren-1,6-diyl group,
 a substituted or unsubstituted fluoren-1,7-diyl group,
 a substituted or unsubstituted fluoren-1,8-diyl group,
 a substituted or unsubstituted fluoren-2,6-diyl group,
 a substituted or unsubstituted fluoren-2,7-diyl group, and
 a substituted or unsubstituted fluoren-3,6-diyl group.

[0029] Preferable are

a substituted or unsubstituted fluoren-1,6-diyl group,
 a substituted or unsubstituted fluoren-1,7-diyl group,
 a substituted or unsubstituted fluoren-1,8-diyl group,
 a substituted or unsubstituted fluoren-2,6-diyl group,
 a substituted or unsubstituted fluoren-2,7-diyl group, and
 a substituted or unsubstituted fluoren-3,6-diyl group.

[0030] More preferable are

a substituted or unsubstituted fluoren-1,8-diyl group,
 a substituted or unsubstituted fluoren-2,7-diyl group, and
 a substituted or unsubstituted fluoren-3,6-diyl group.

[0031] Further preferable is a substituted or unsubstituted fluoren-2,7-diyl group.

[0032] In the compounds represented by the formula (1), j , m and n represent 0 or 1, and k and 1 represent 1 or 2. Preferable examples can include cases where (1) k is 1, (2) j and n are 0, 1 is 1 and $k + m$ is 2, (3) $j + 1 + n$ is 2, k is 1 and m is 0 and (4) j , m and n are 0 and k and 1 are 1.

[0033] The compounds represented by the formula (1) are roughly classified into the following structures depending on values of j , k , 1, m and n .



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$X_1-F_1-A_1-A_1-F_2-X_2$ (1h)

5 $X_1-A_1-F_2-F_2-A_2-X_2$ (1i)

$X_1-A_1-A_1-F_2-A_2-X_2$ (1j)

10 $X_1-A_1-A_1-F_2-F_2-X_2$ (1k)

15 $X_1-A_1-F_2-F_2-F_3-X_2$ (1l)

$X_1-F_1-A_1-F_2-A_2-F_3-X_2$ (1m)

20 $X_1-F_1-A_1-F_2-F_2-A_2-X_2$ (1n)

$X_1-F_1-A_1-A_1-F_2-A_2-X_2$ (1o)

25 $X_1-F_1-A_1-A_1-F_2-F_2-X_2$ (1p)

30 $X_1-A_1-A_1-F_2-F_2-A_2-X_2$ (1q)

$X_1-F_1-A_1-F_2-F_2-F_3-X_2$ (1r)

35 $X_1-A_1-A_1-F_2-A_2-F_3-X_2$ (1s)

40 $X_1-A_1-A_1-F_2-F_2-F_3-X_2$ (1t)

$X_1-F_1-A_1-A_1-F_2-F_2-A_2-X_2$ (1u)

45 $X_1-F_1-A_1-F_2-F_2-A_2-F_3-X_2$ (1v)

$X_1-F_1-A_1-A_1-F_2-A_2-F_3-X_2$ (1w)

50 $X_1-F_1-A_1-A_1-F_2-F_2-F_3-X_2$ (1x)

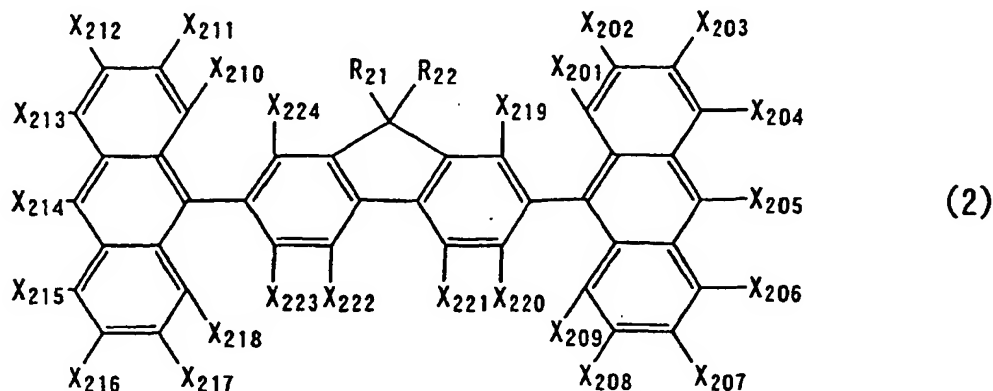
55 $X_1-A_1-A_1-F_2-F_2-A_2-F_3-X_2$ (1y)

$X_1-F_1-A_1-A_1-F_2-F_2-A_2-F_3-X_2$ (1z)

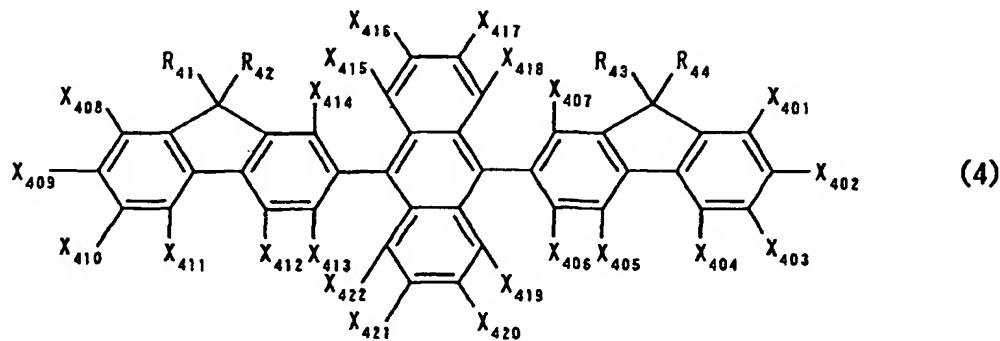
wherein A_1 , A_2 , F_1 , F_2 , F_3 , X_1 and X_2 have the same meanings as in the formula (1).

[0034] Of these structures, the structures represented by (1a), (1b), (1c), (1d), (1f), (1g), (1i), (1l), (1m), (1n), (1r), (1v) and (1y) are preferable. The structures represented by (1a), (1b), (1c), (1f), (1g), (1i), (1m) and (1v) are more preferable. The structures represented by (1a), (1b), (1c) and (1m) are further preferable.

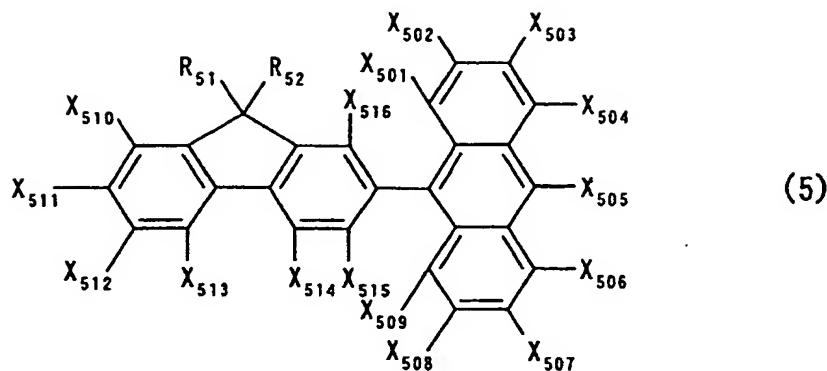
[0035] Moreover, preferable examples of the compounds represented by the formula (1) can include compounds represented by the following the formula (2), the formula (4) and the formula (5).



wherein R_{21} and R_{22} , independently from each other, represent a hydrogen atom, a linear, branched or cyclic alkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, and X_{201} to X_{214} , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, or a substituted or unsubstituted aryl group, provided R_{21} , R_{22} and X_{201} to X_{224} are not an anthryl group or a fluorenyl group,



wherein R_{41} to R_{44} , independently from each other, represent a hydrogen atom, a linear, branched or cyclic alkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, and X_{401} to X_{422} , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, or a substituted or unsubstituted aryl group, provided R_{41} to R_{44} and X_{401} to X_{422} are not an anthryl group or a fluorenyl group,



wherein R₅₁ and R₅₂, independently from each other, represent a hydrogen atom, a linear, branched or cyclic alkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, and X₅₀₁ to X₅₁₆, independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, or a substituted or unsubstituted aryl group, provided R₅₁, R₅₂ and X₅₀₁ to X₅₁₆ are not an anthryl group or a fluorenyl group.

[0036] In the compounds represented by the formula (2), the formula (4) and the formula (5), R₂₁, R₂₂, R₄₁ to R₄₄, R₅₁ and R₅₂, independently from each other, represent a hydrogen atom, a linear, branched or cyclic alkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, provided R₂₁, R₂₂, R₄₁ to R₄₄, R₅₁ and R₅₂ are not an anthryl group or a fluorenyl group.

[0037] Incidentally, the aryl group refers to carbocyclic aromatic groups such as a phenyl group, a naphthyl group and the like, and heterocyclic aromatic groups such as a furfuryl group, a thienyl group, a pyridyl group and the like.

[0038] R₂₁, R₂₂, R₄₁ to R₄₄, R₅₁ and R₅₂ are preferably a hydrogen atom, a linear, branched or cyclic alkyl group having 1 to 16 carbon atoms, a substituted or unsubstituted carbocyclic aromatic group having 6 to 25 carbon atoms, a substituted or unsubstituted heterocyclic aromatic group having 3 to 25 carbon atoms, or a substituted or unsubstituted aralkyl group having 5 to 16 carbon atoms, more preferably a hydrogen atom, a linear, branched or cyclic alkyl group having 1 to 10 carbon atoms, a substituted or unsubstituted carbocyclic aromatic group having 6 to 12 carbon atoms, a substituted or unsubstituted heterocyclic aromatic group having 4 to 12 carbon atoms, or a substituted or unsubstituted aralkyl group having 7 to 12 carbon atoms, further preferably a hydrogen atom, a linear, branched or cyclic alkyl group having 1 to 8 carbon atoms, a substituted or unsubstituted carbocyclic aromatic group having 6 to 10 carbon atoms, a substituted or unsubstituted heterocyclic aromatic group having 4 to 10 carbon atoms, or a substituted or unsubstituted aralkyl group having 7 to 10 carbon atoms.

[0039] Specific examples of R₂₁, R₂₂, R₄₁ to R₄₄, R₅₁ and R₅₂ can include a hydrogen atom, and a linear, branched or cyclic alkyl group, a substituted or unsubstituted carbocyclic aromatic group, a substituted or unsubstituted heterocyclic aromatic group and a substituted or unsubstituted aralkyl group listed as specific examples of X₁ and X₂.

[0040] In the compounds represented by the formula (2), the formula (4) and the formula (5), X₂₀₁ to X₂₂₄, X₄₀₁ to X₄₂₂ and X₅₀₁ to X₅₁₆, independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, or a substituted or unsubstituted aryl group, provided X₂₀₁ to X₂₂₄, X₄₀₁ to X₄₂₂ and X₅₀₁ to X₅₁₆ are not an anthryl group or a fluorenyl group.

[0041] Incidentally, the aryl group refers to carbocyclic aromatic groups such as a phenyl group, a naphthyl group and the like, and heterocyclic aromatic groups such as a furfuryl group, a thienyl group, a pyridyl group and the like.

[0042] X₂₀₁ to X₂₂₄, X₄₀₁ to X₄₂₂ and X₅₀₁ to X₅₁₆ are preferably a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group having 1 to 16 carbon atoms, a linear, branched or cyclic alkoxy group having 1 to 16 carbon atoms, a substituted amino group having 1 to 24 carbon atoms, a substituted or unsubstituted carbocyclic aromatic group having 6 to 25 carbon atoms, or a substituted or unsubstituted heterocyclic aromatic group having 3 to 25 carbon atoms, more preferably a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group having 1 to 10 carbon atoms, a linear, branched or cyclic alkoxy group having 1 to 10 carbon atoms, a substituted amino group having 1 to 20 carbon atoms, a substituted or unsubstituted carbocyclic aromatic group having 6 to 12 carbon atoms, or a substituted or unsubstituted heterocyclic aromatic group having 4 to 12 carbon atoms, further preferably a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group having 1 to 8 carbon atoms, a linear, branched or cyclic alkoxy group having 1 to 8 carbon atoms, a substituted amino group having 2 to 20 carbon atoms, a substituted or unsubstituted carbocyclic aromatic group having 6 to 10 carbon atoms, or a substituted or unsubstituted heterocyclic aromatic group having 4 to 10 carbon atoms.

[0043] Specific examples of X_{201} to X_{224} , X_{401} to X_{422} and X_{501} to X_{518} can include a hydrogen atom, and a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, a substituted or unsubstituted carbocyclic aromatic group and a substituted or unsubstituted heterocyclic aromatic group listed as specific examples of X_1 and X_2 .

[0044] The compounds represented by the formula (2) are preferably compounds in which X_{205} and X_{214} are a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, or a substituted or unsubstituted aryl group, and compounds in which X_{201} , X_{204} , X_{206} , X_{209} , X_{210} , X_{213} , X_{215} and X_{218} are a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, or a linear, branched or cyclic alkoxy group, more preferably compounds in which X_{205} and X_{214} are a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, or a substituted or unsubstituted heterocyclic aromatic group.

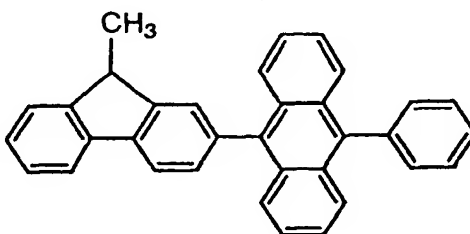
[0045] The compounds represented by the formula (4) are preferably compounds in which X_{415} , X_{418} , X_{419} and X_{422} are a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, or a linear, branched or cyclic alkoxy group.

[0046] The compounds represented by the formula (5) are preferably compounds in which X_{505} is a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, or a substituted or unsubstituted aryl group, and compounds in which X_{501} , X_{504} , X_{506} and X_{509} are a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, or a linear, branched or cyclic alkoxy group.

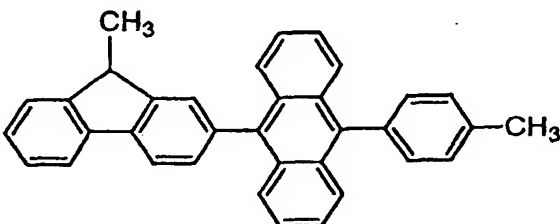
[0047] Specific examples of compounds A according to the invention can include the following compounds. However, the invention is not limited thereto.

[0048] Illustrative Compound No.

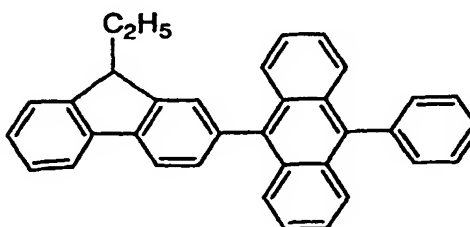
A-1



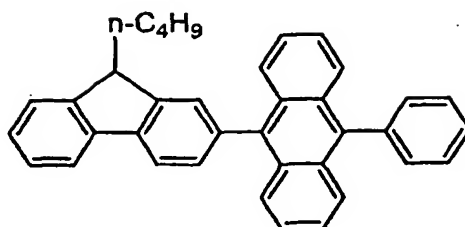
A-2



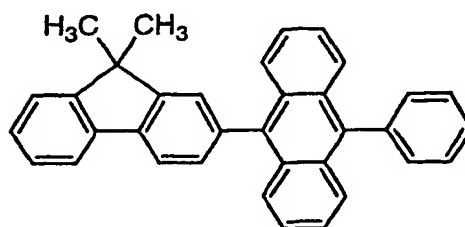
A-3



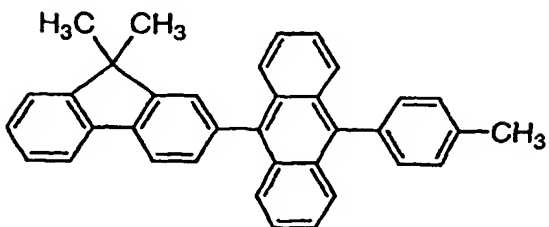
A-4



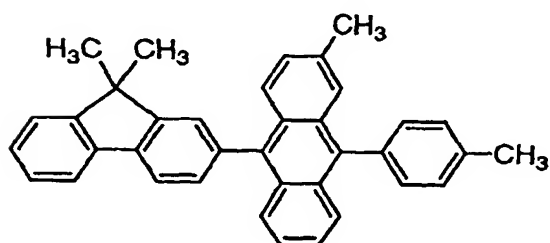
A-5



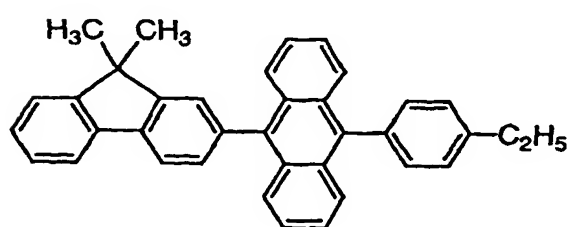
A-6



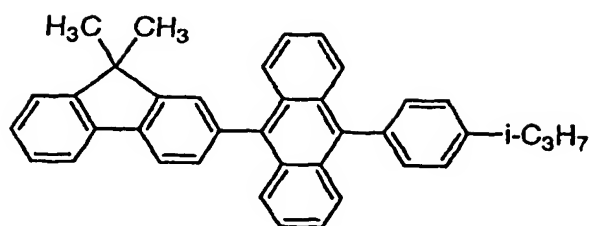
A-7



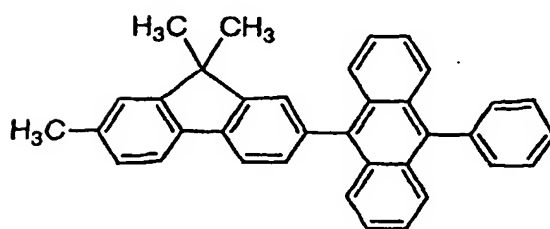
A-8



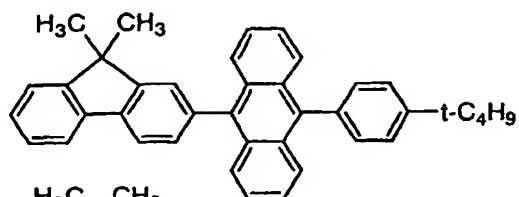
A-9



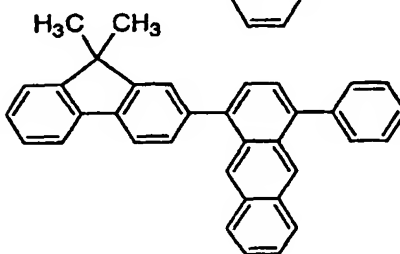
A-10



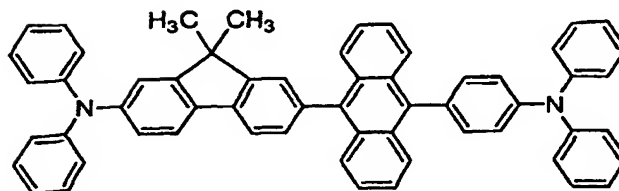
A-11



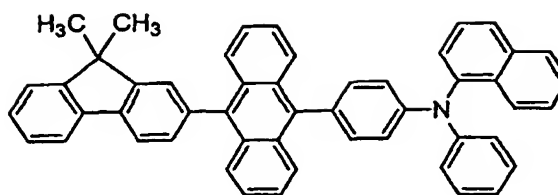
A-12



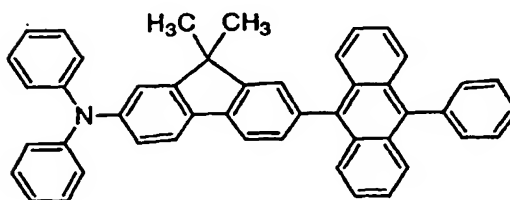
A-13



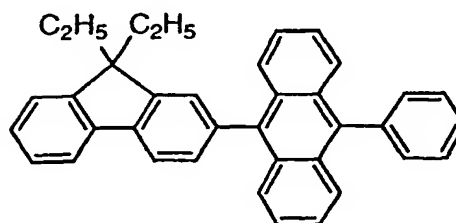
A-14



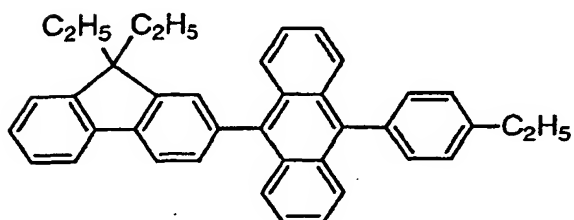
A-15



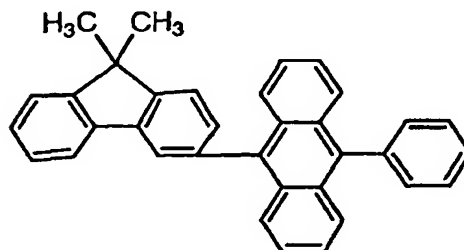
A-16



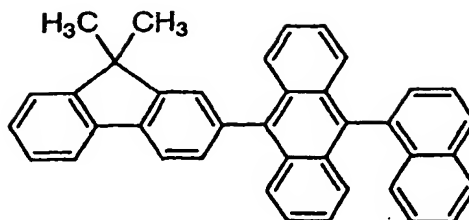
A-17



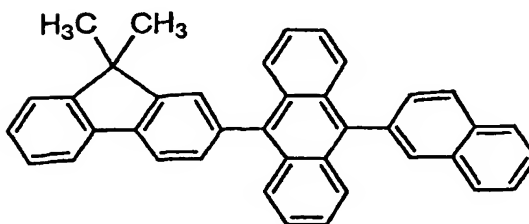
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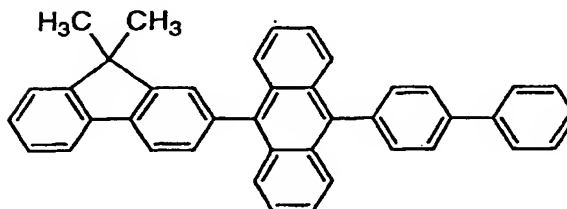
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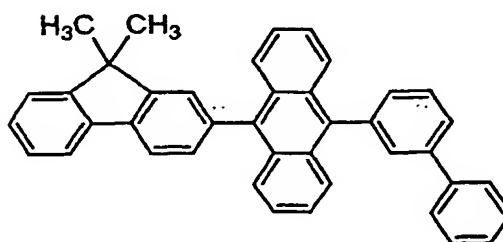
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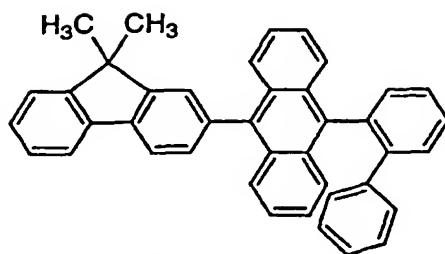
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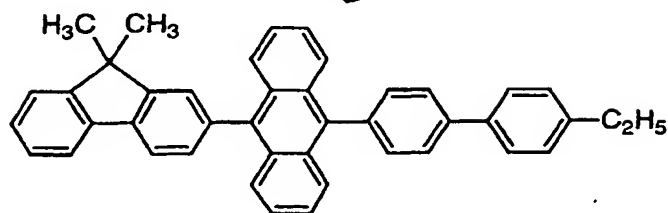
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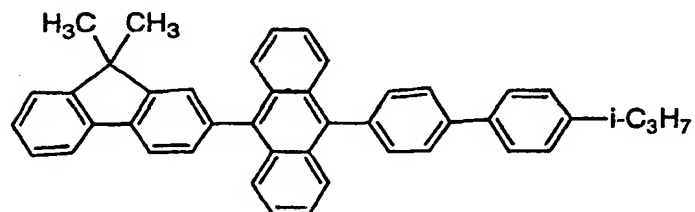
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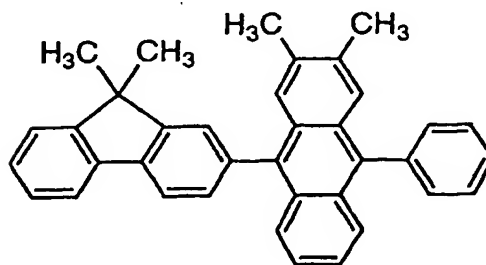
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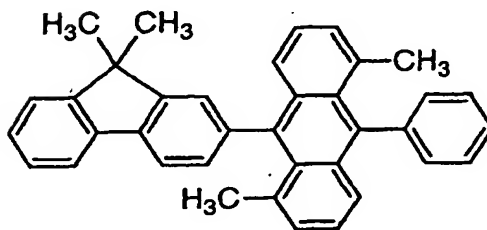
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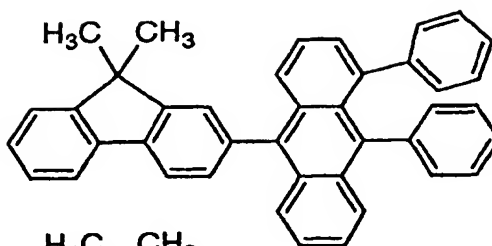
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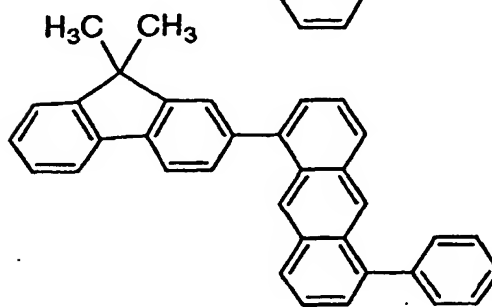
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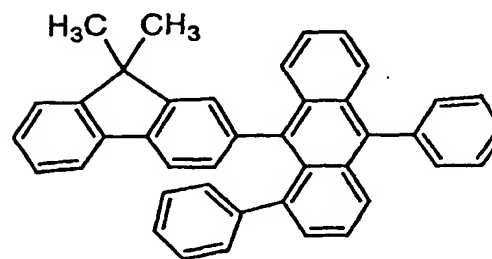
A-28



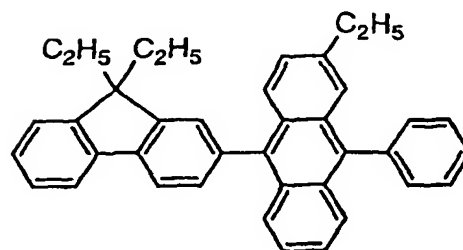
A-29



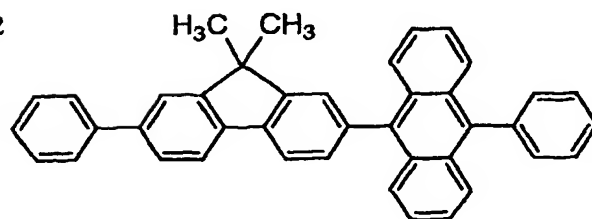
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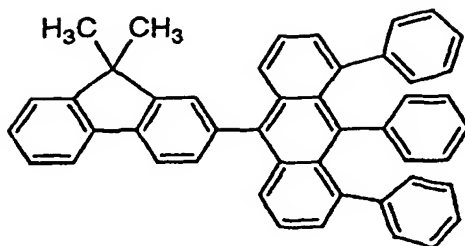
A-31



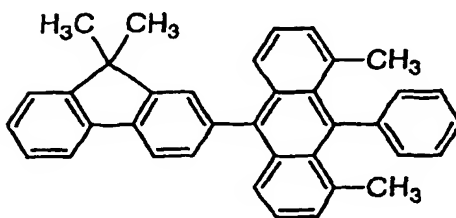
A-32



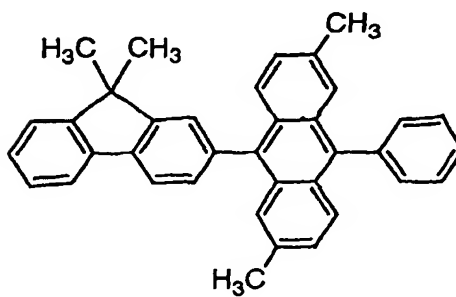
A-33



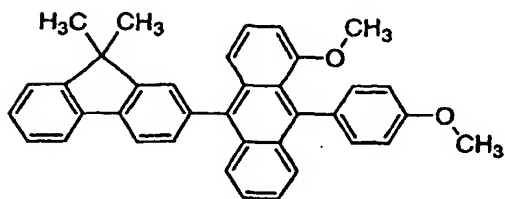
A-34



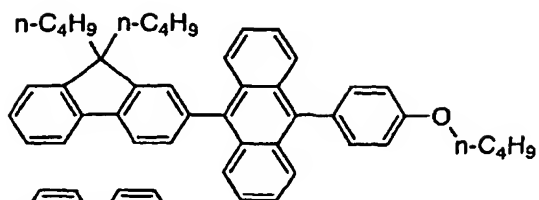
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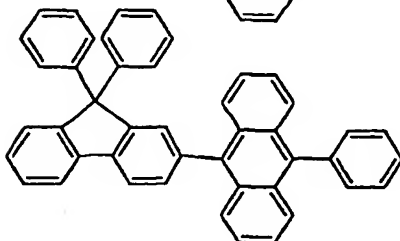
A-36



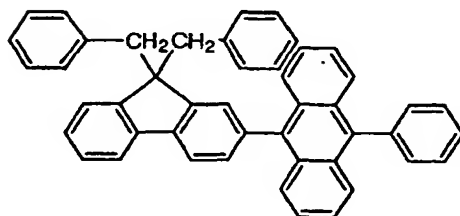
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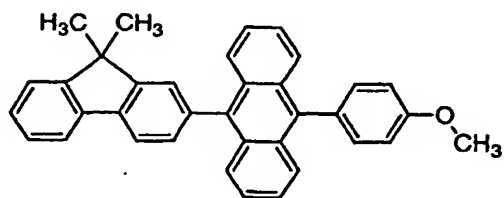
A-38



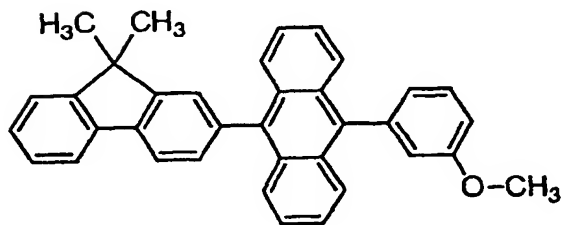
A-39



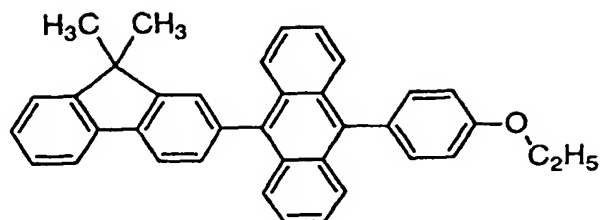
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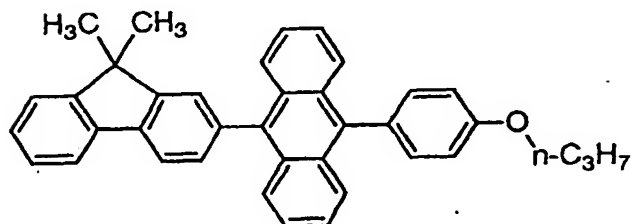
A-41



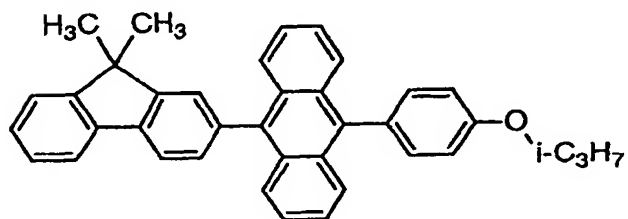
A-42



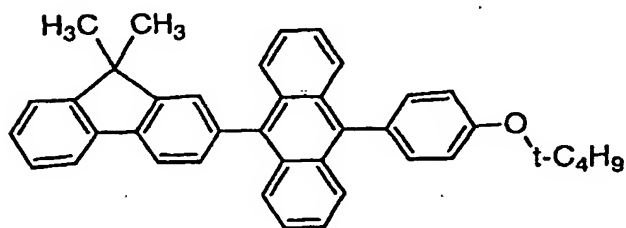
A-43



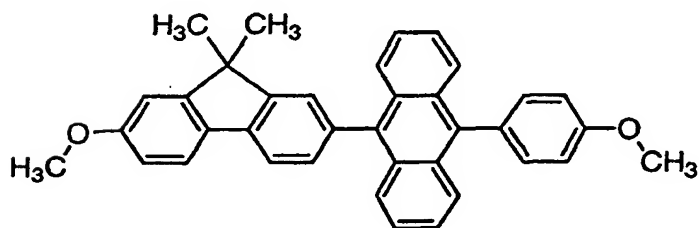
A-44



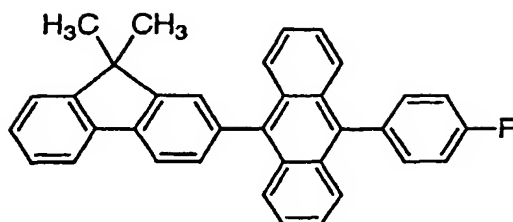
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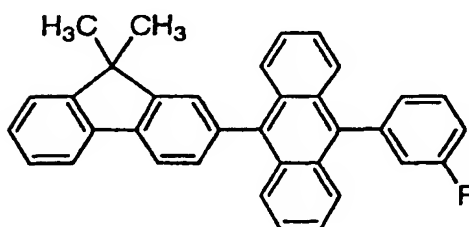
A-46



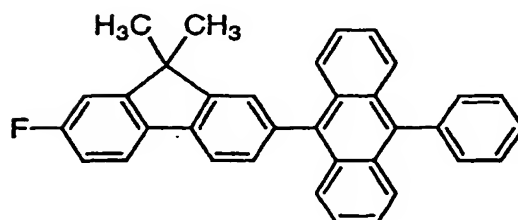
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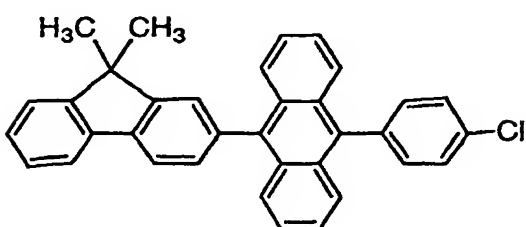
A-48



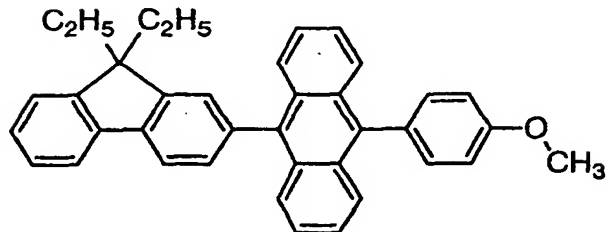
A-49



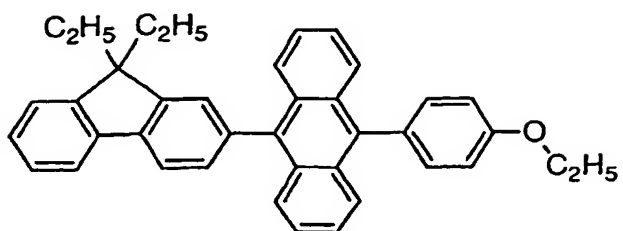
A-50



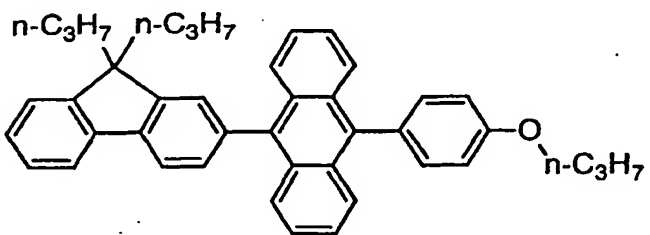
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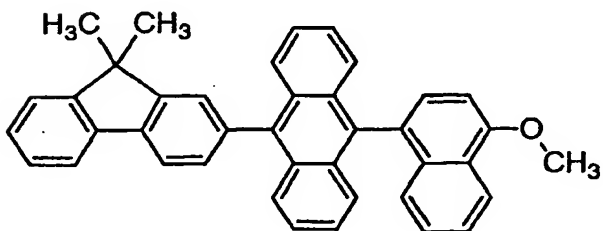
A-52



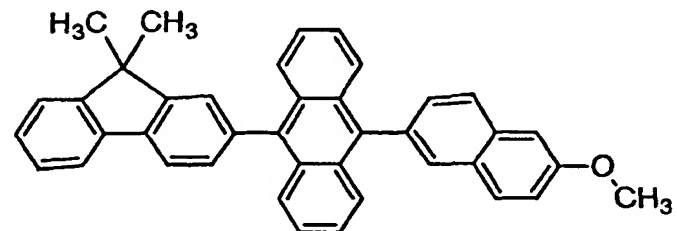
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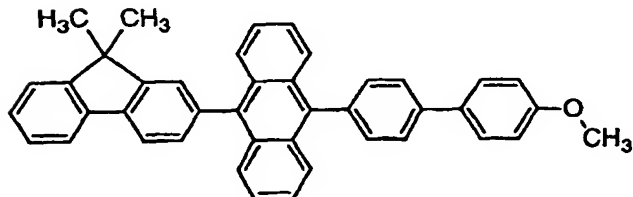
A-54



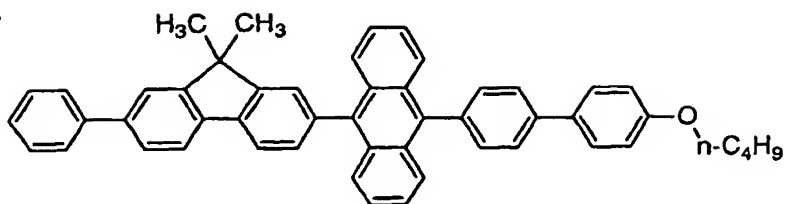
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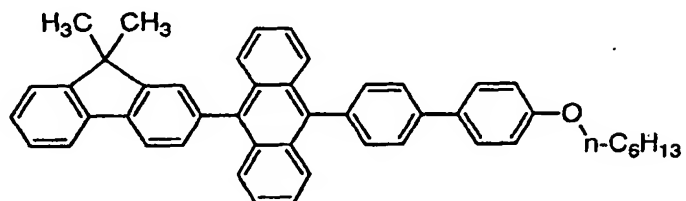
A-56



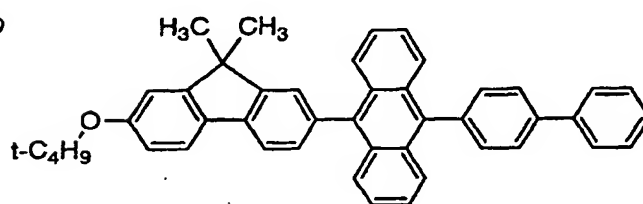
A-57



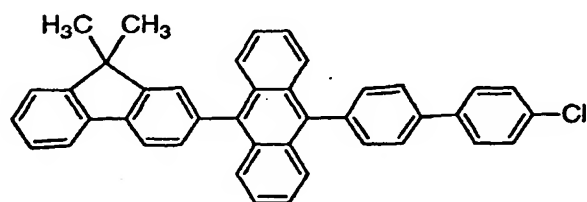
A-58



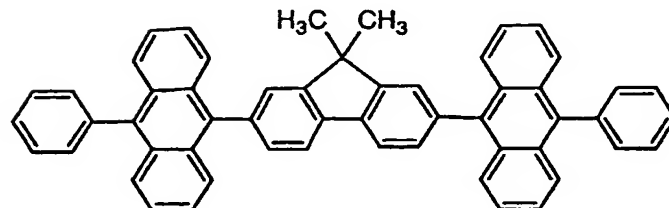
A-59



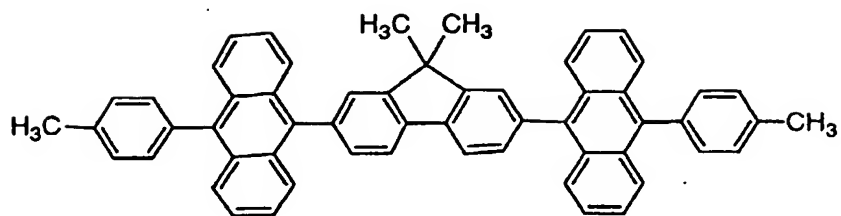
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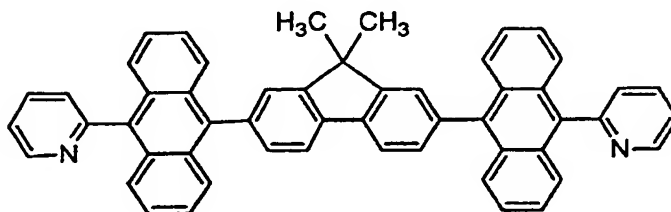
B-1



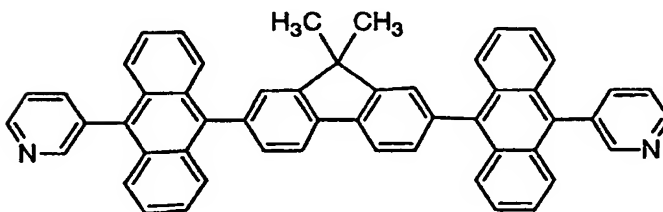
B-2



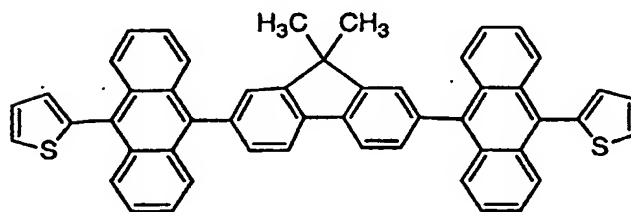
B-3



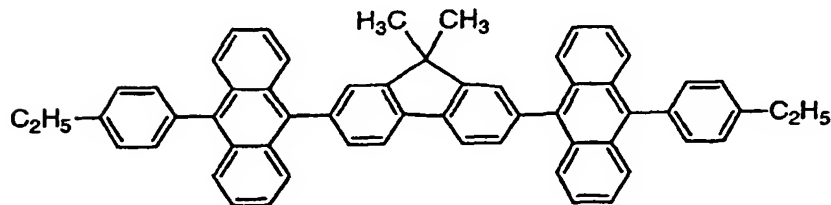
B-4



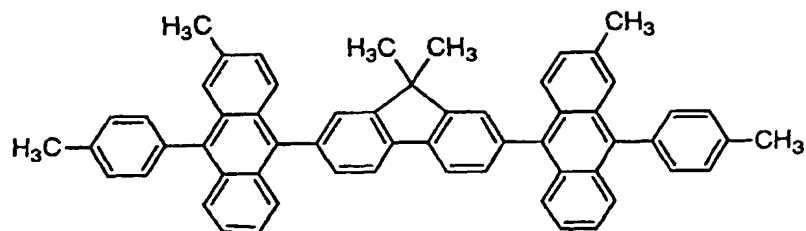
B-5



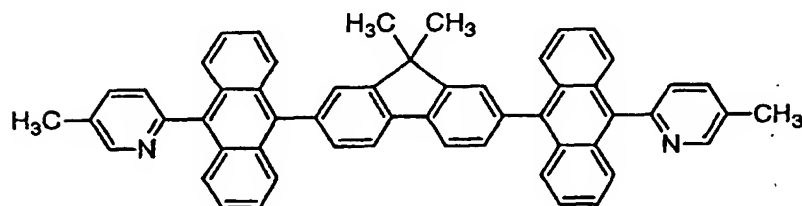
B-6



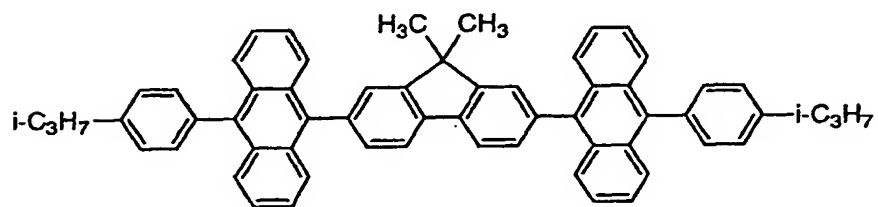
B-7



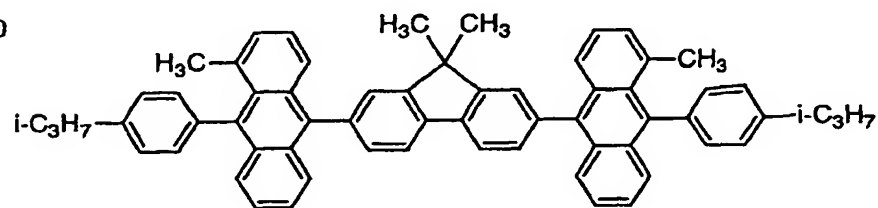
B-8



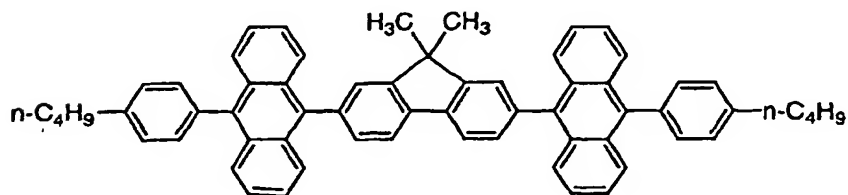
B-9

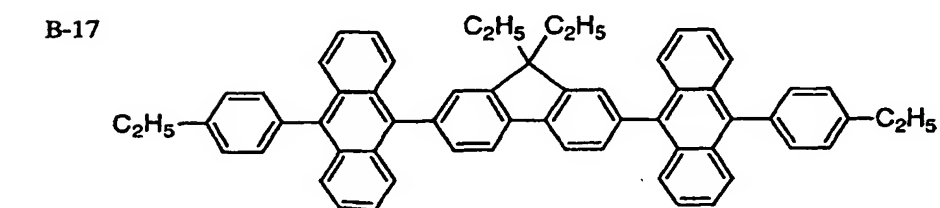
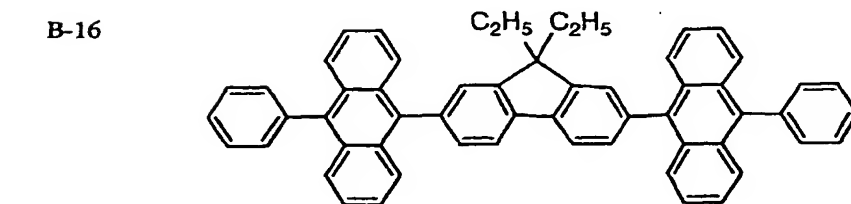
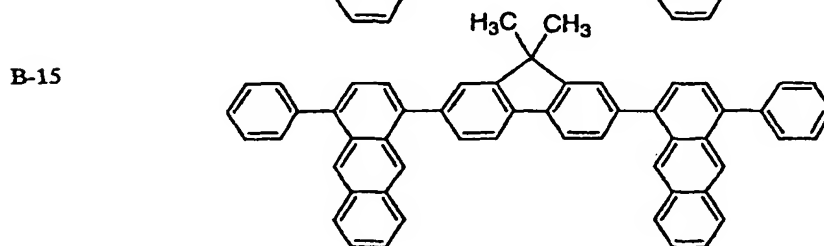
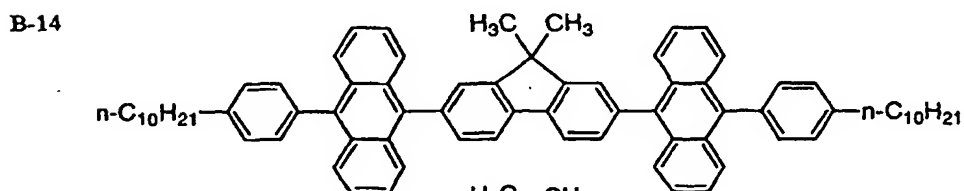
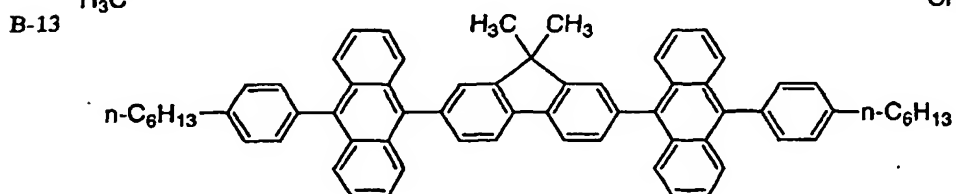
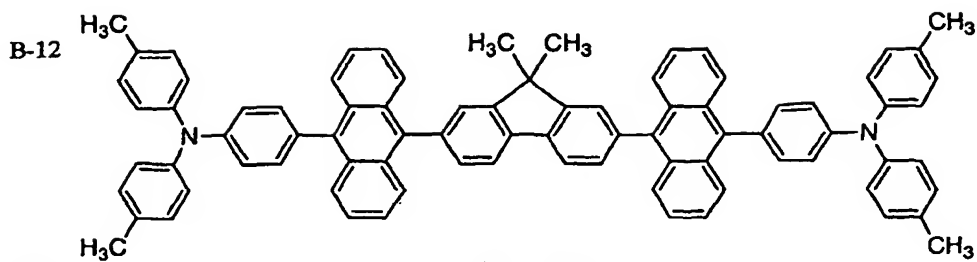


B-10

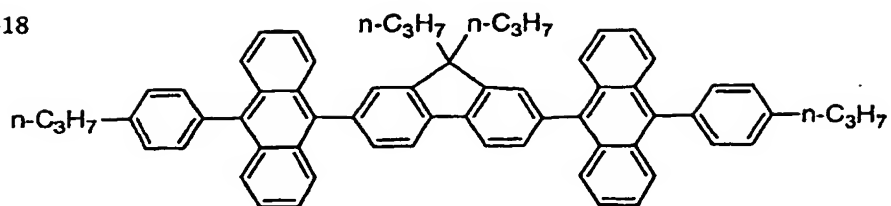


B-11

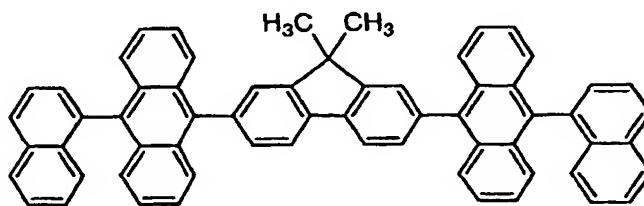




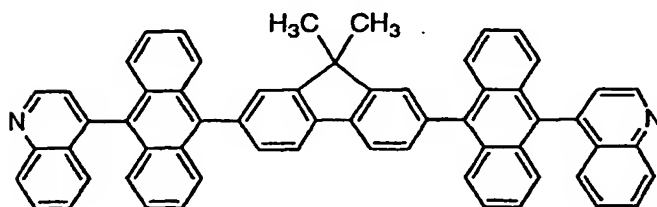
B-18



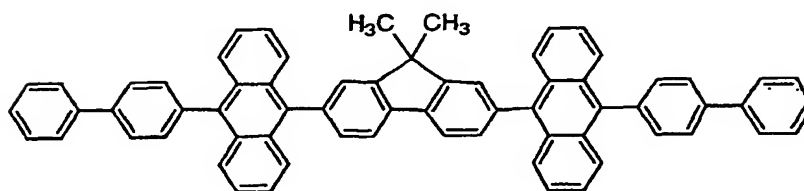
B-19



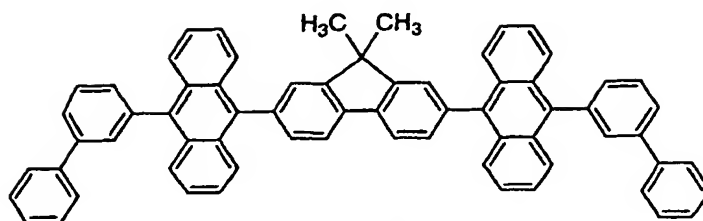
B-20



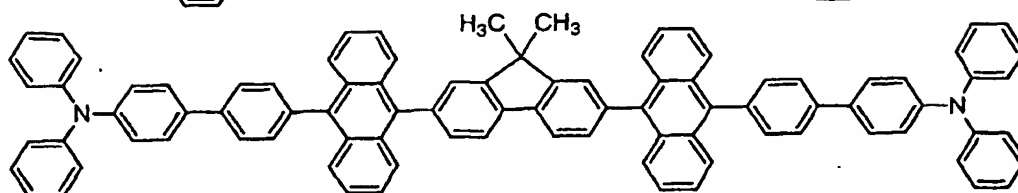
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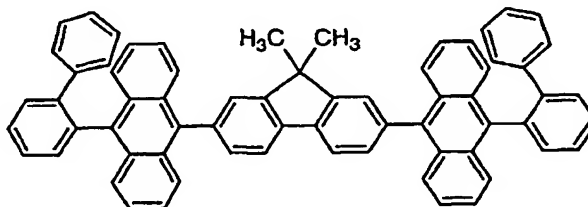


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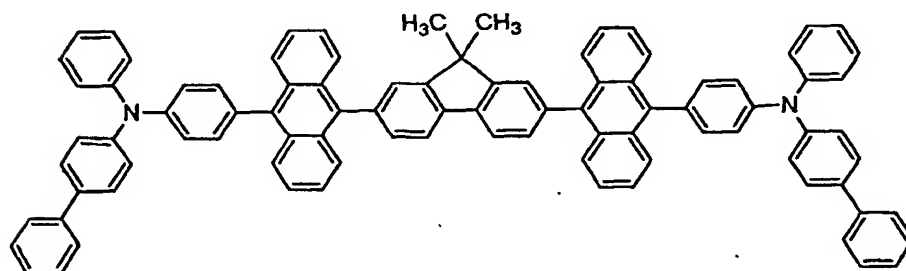
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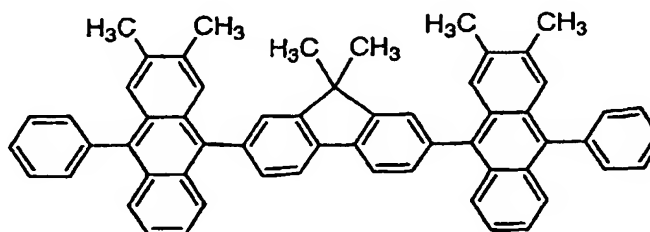
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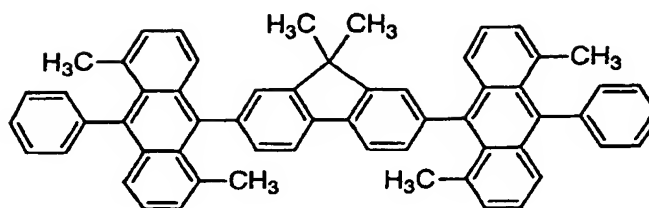
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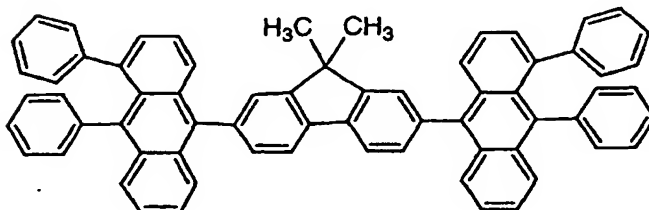
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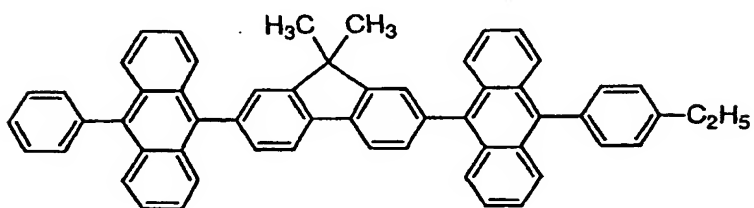
B-27



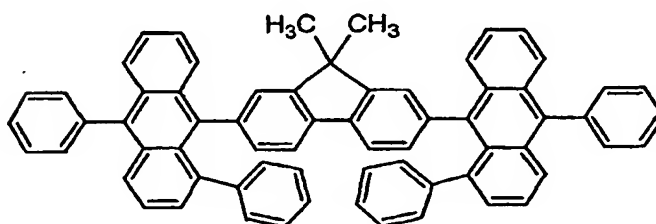
B-28



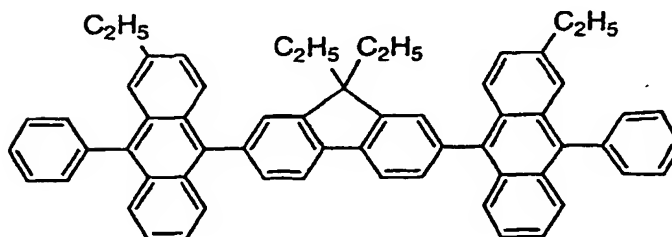
B-29



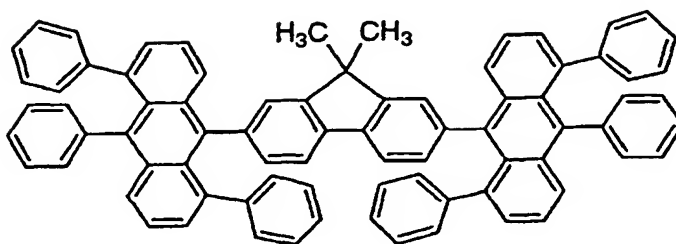
B-30



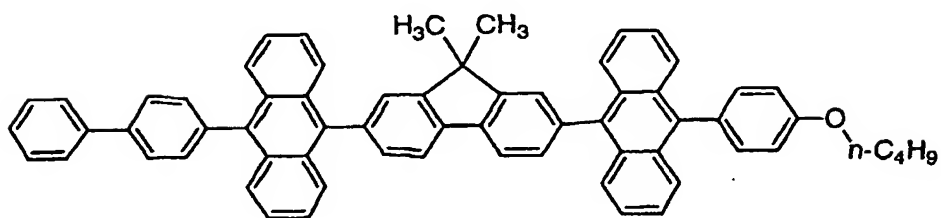
B-31



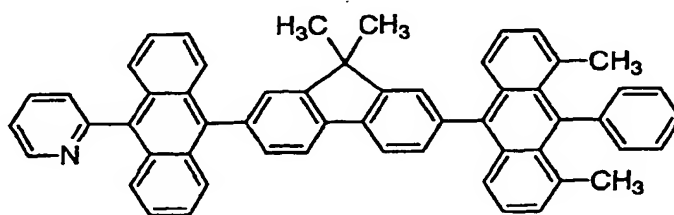
B-32



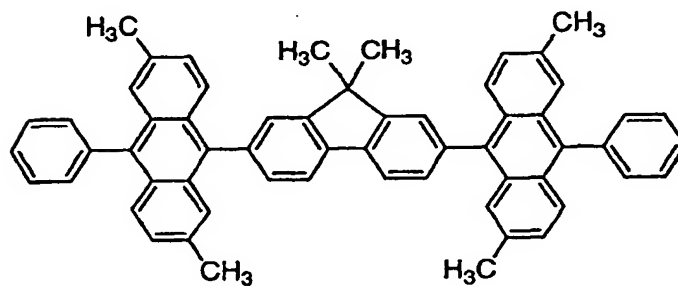
B-33



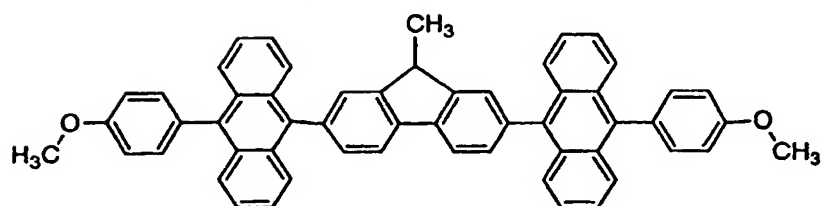
B-34



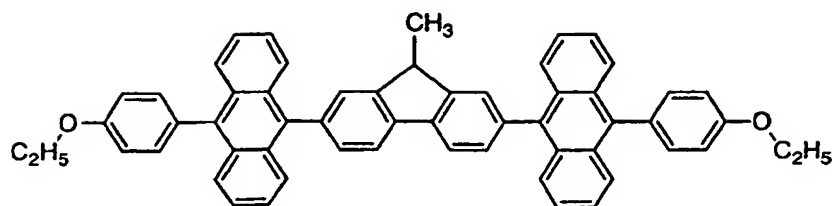
B-35



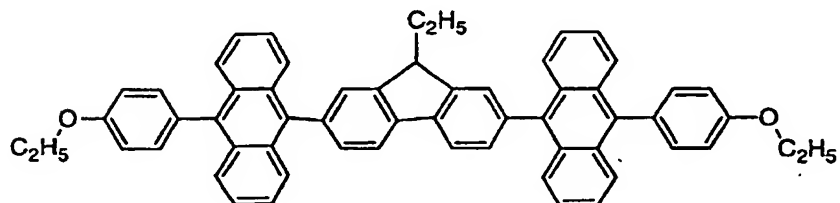
B-36



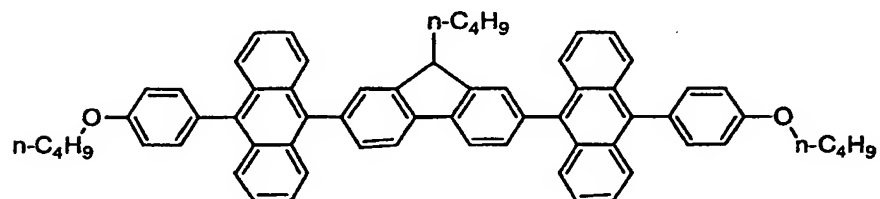
B-37



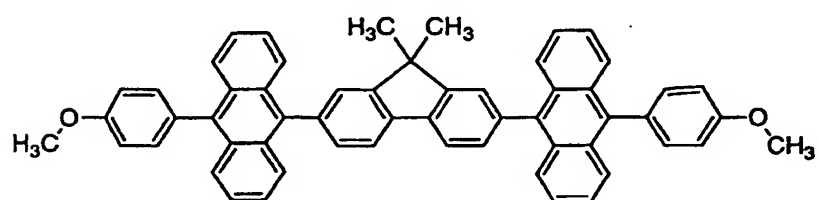
B-38



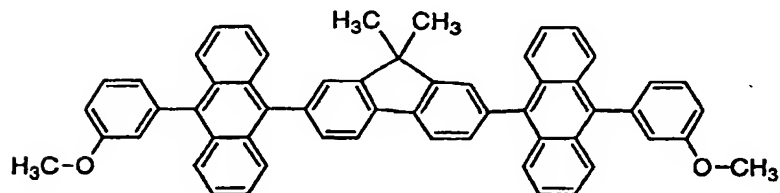
B-39



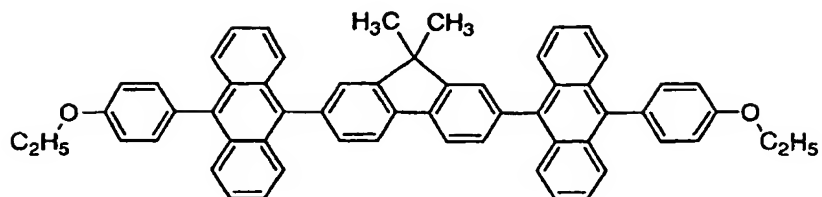
B-40



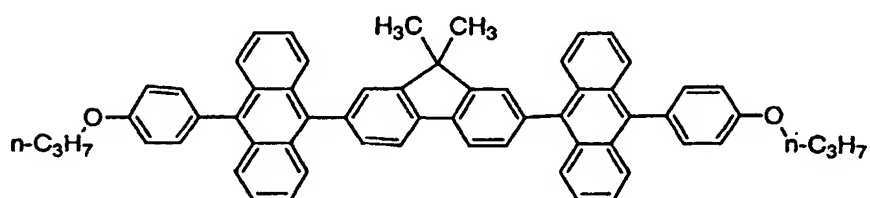
B-41



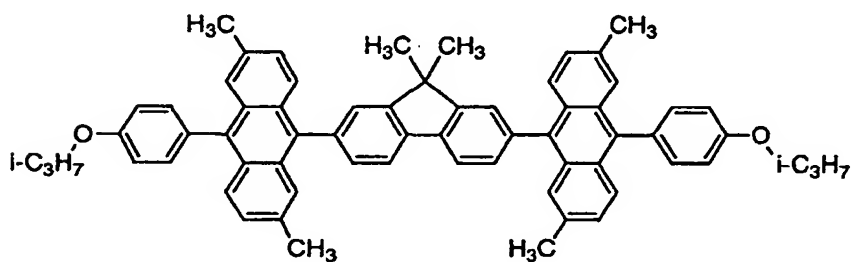
B-42



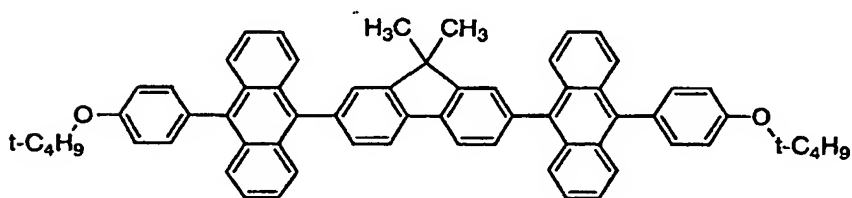
B-43



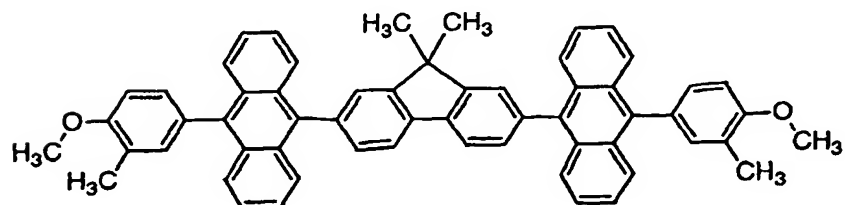
B-44



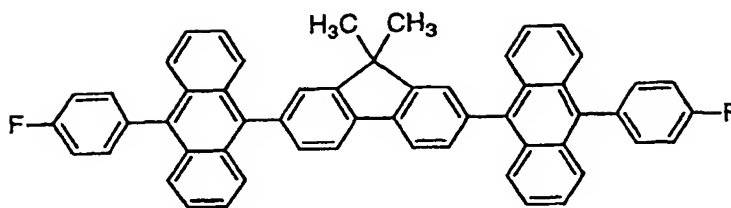
B-45



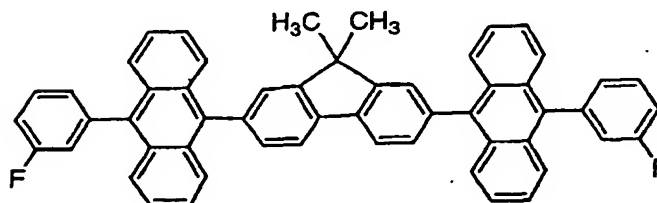
B-46



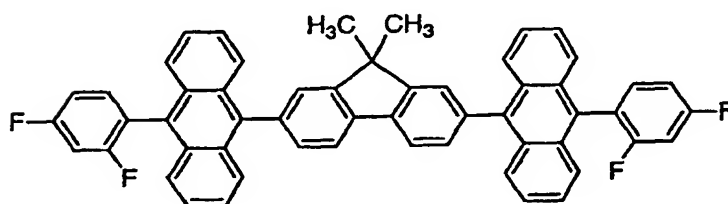
B-47



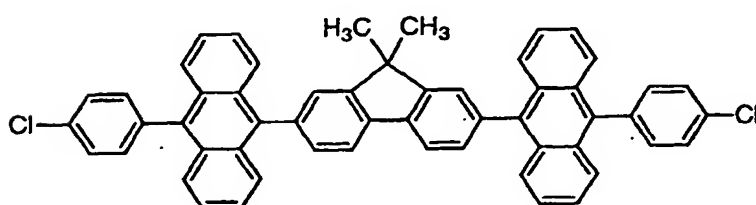
B-48



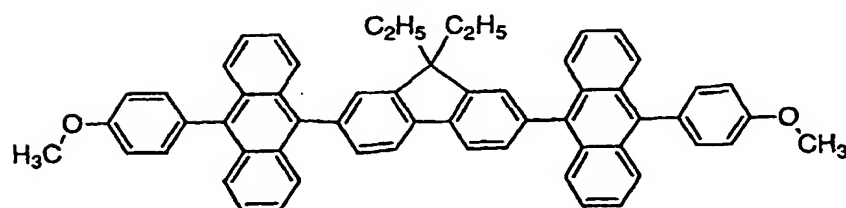
B-49



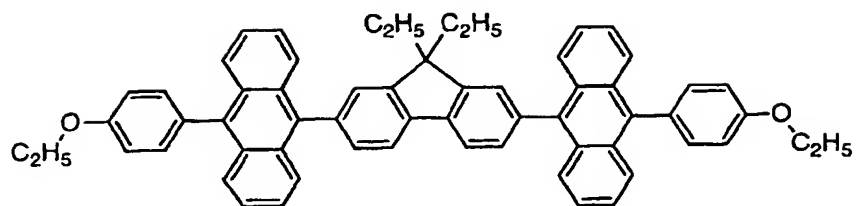
B-50



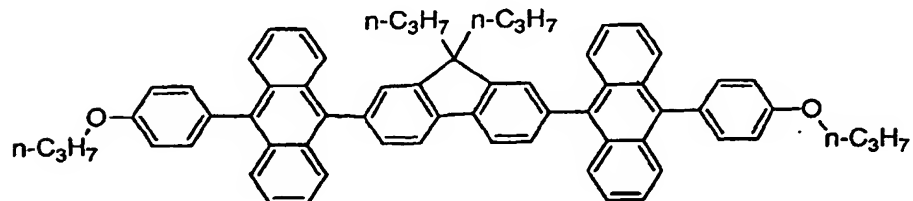
B-51



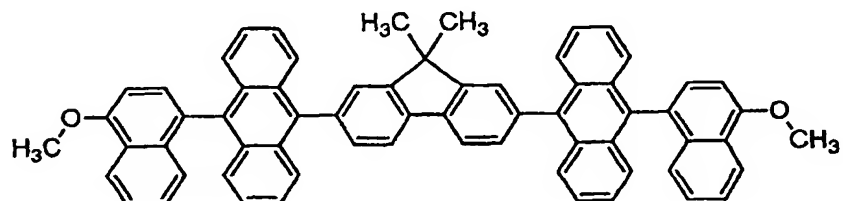
B-52



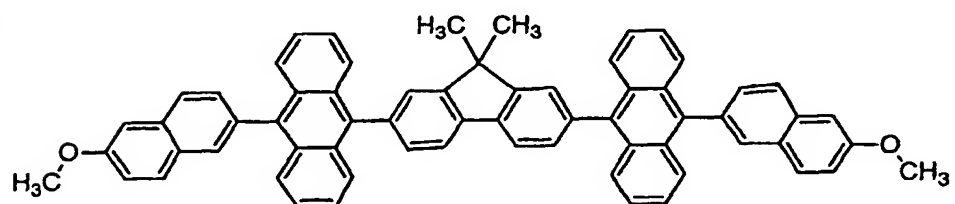
B-53



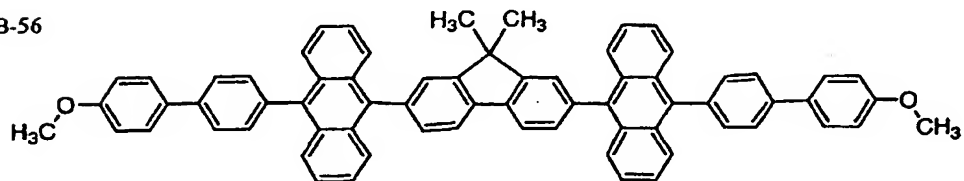
B-54

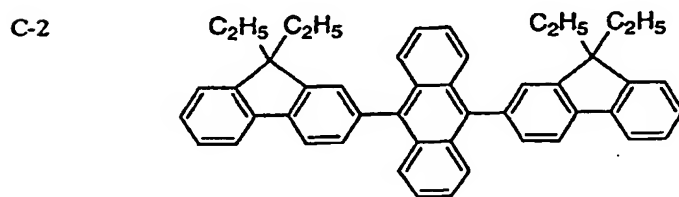
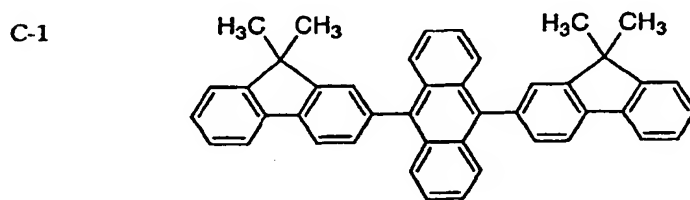
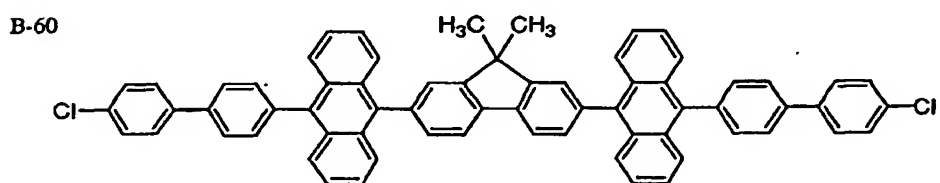
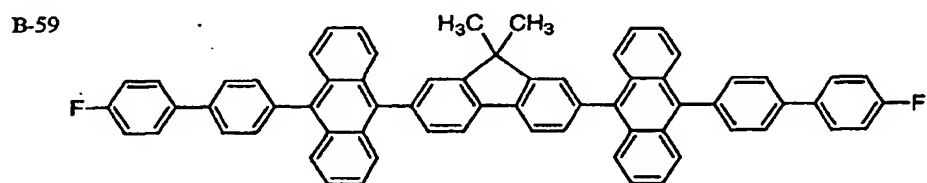
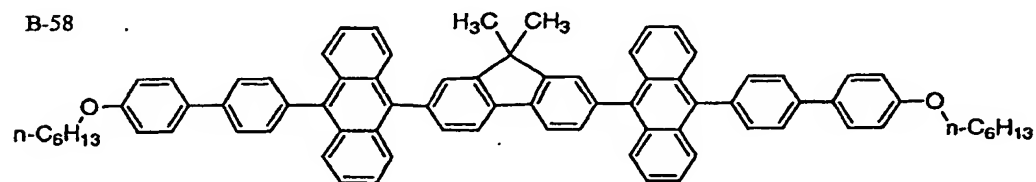
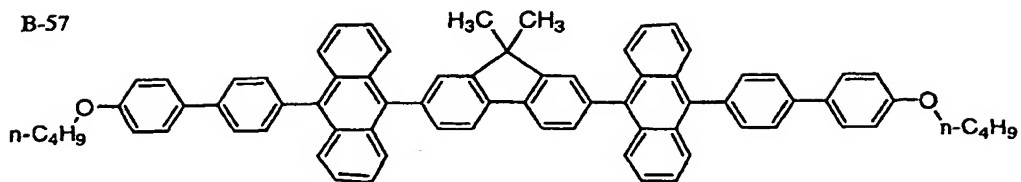


B-55

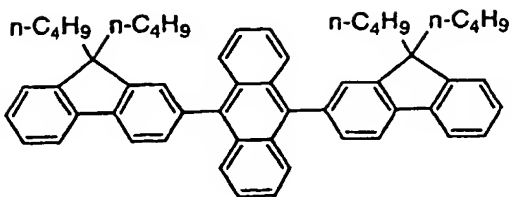


B-56

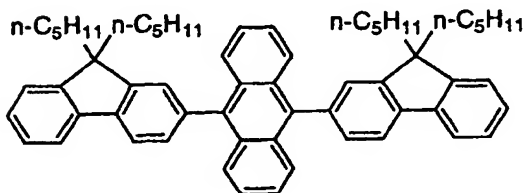




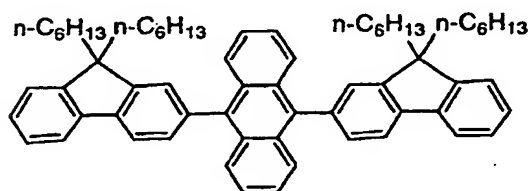
C-3



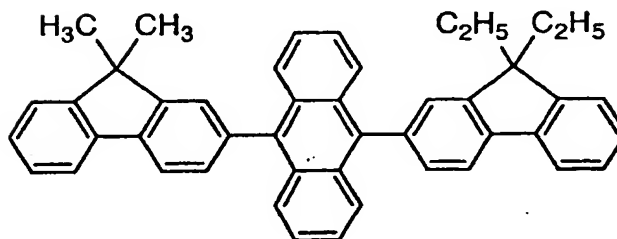
C-4



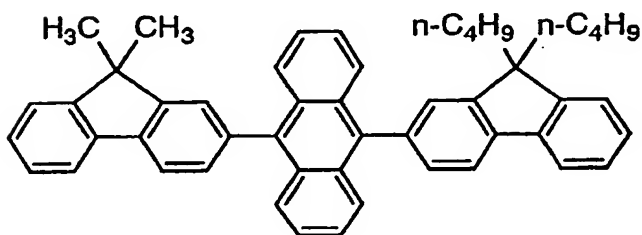
C-5



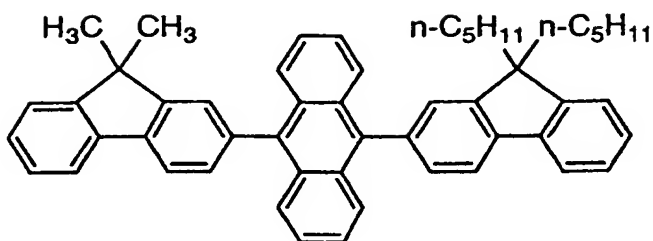
C-6



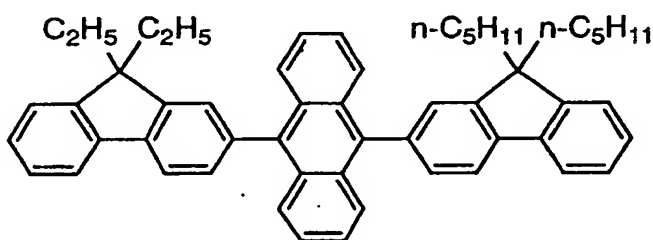
C-7



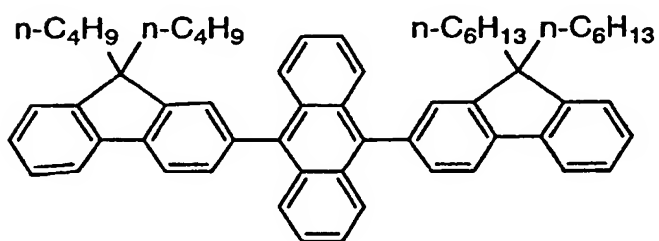
C-8

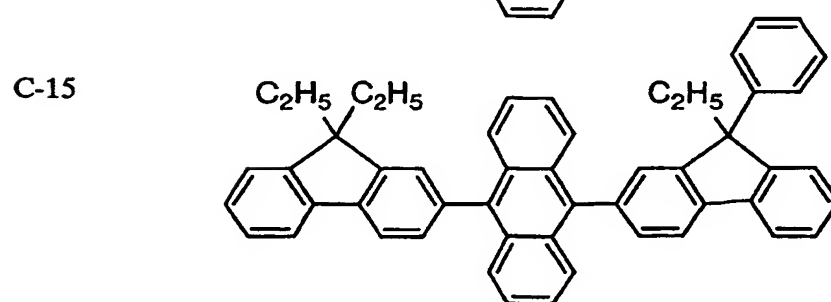
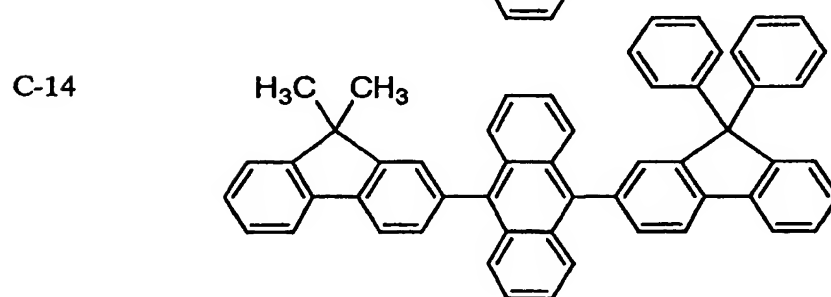
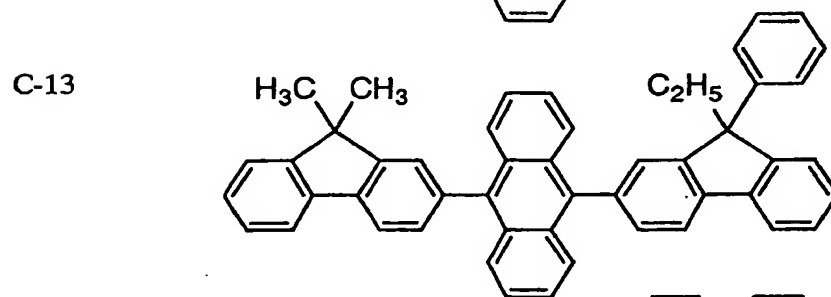
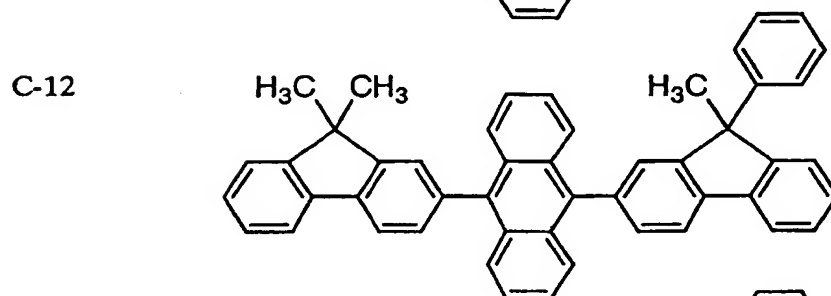
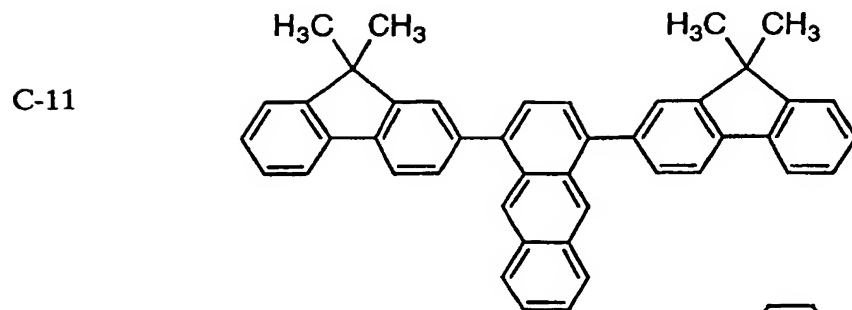


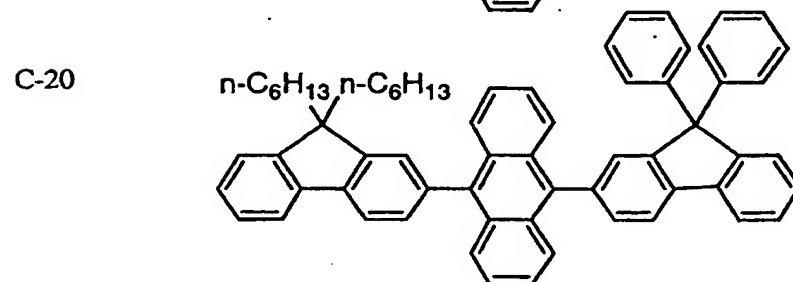
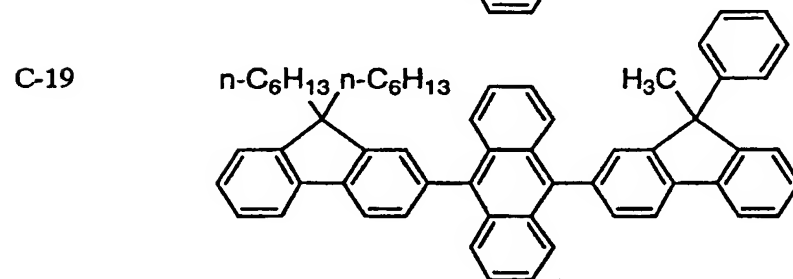
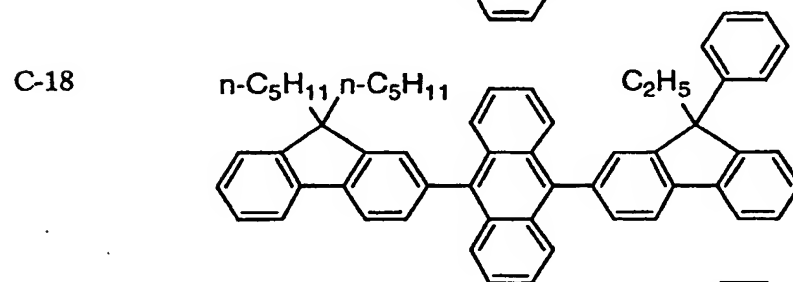
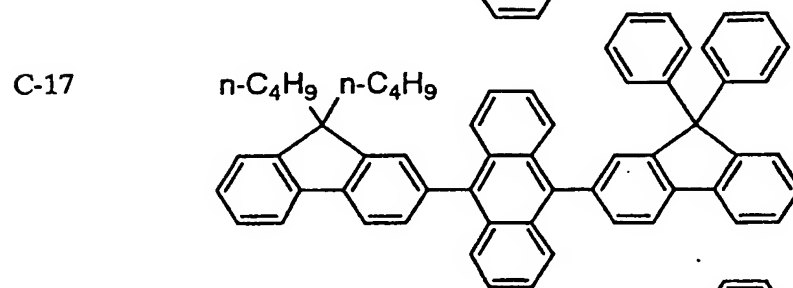
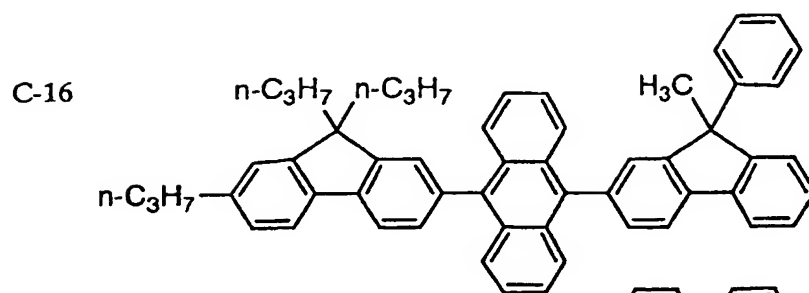
C-9



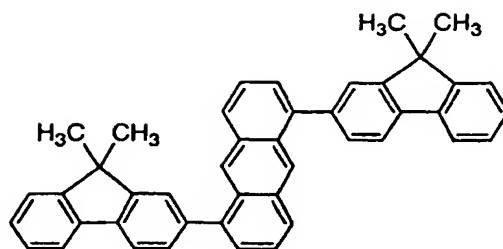
C-10



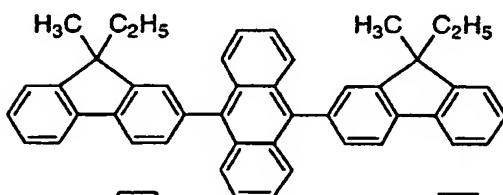




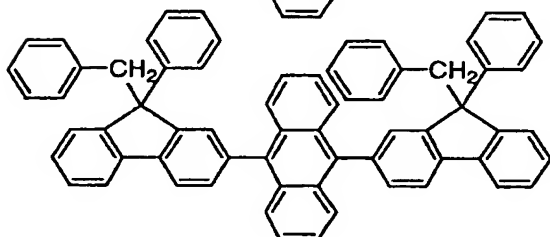
C-21



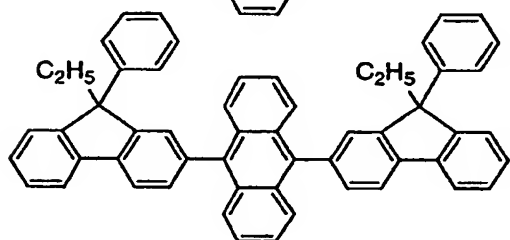
C-22



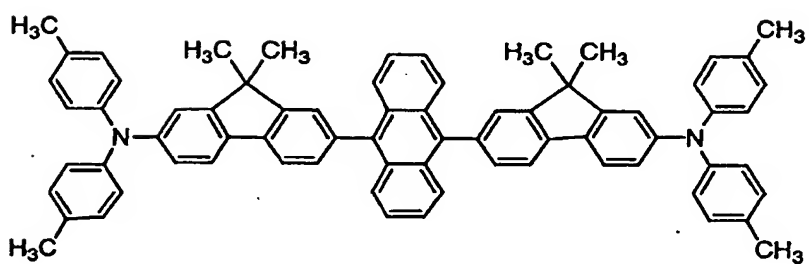
C-23



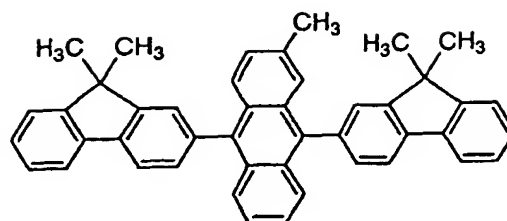
C-24



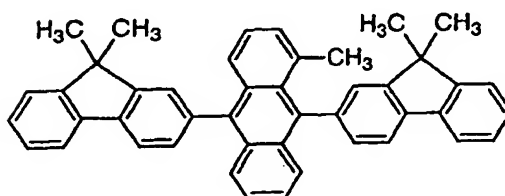
C-25



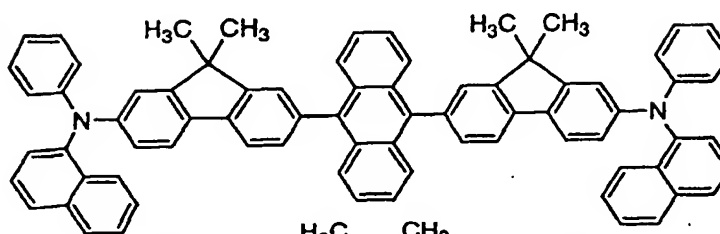
C-26



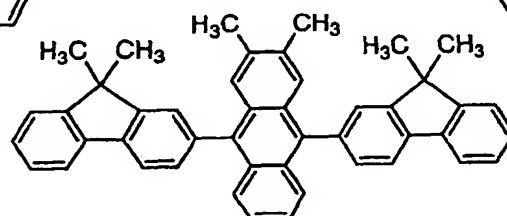
C-27



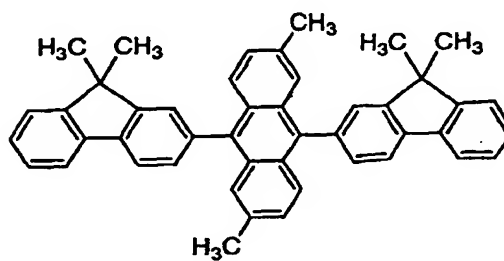
C-28



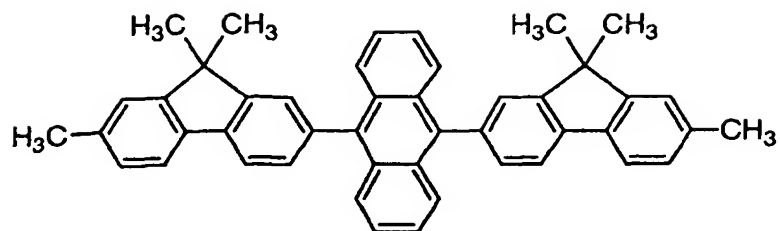
C-29



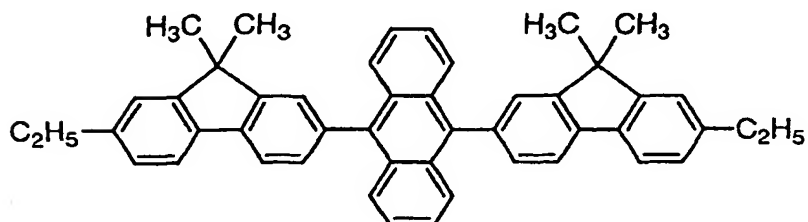
C-30



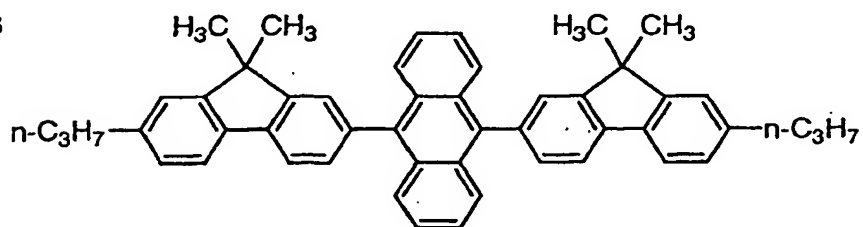
C-31



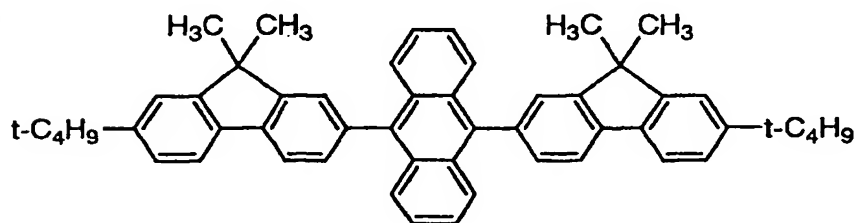
C-32



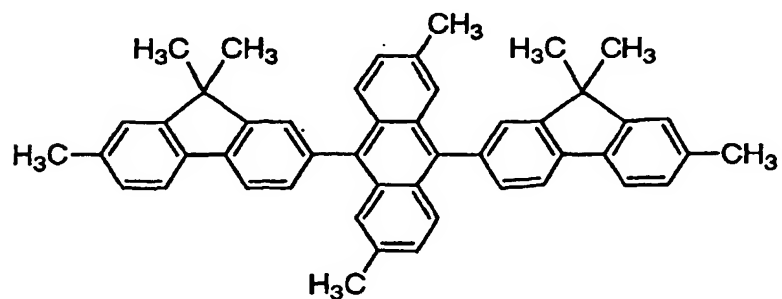
C-33

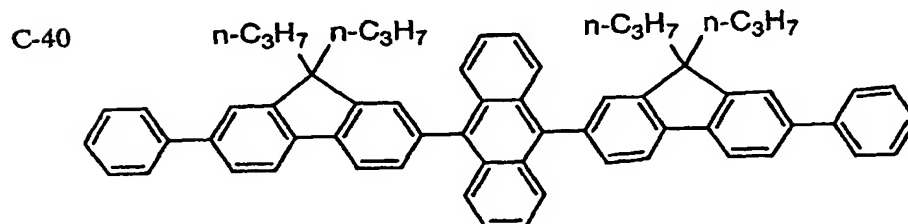
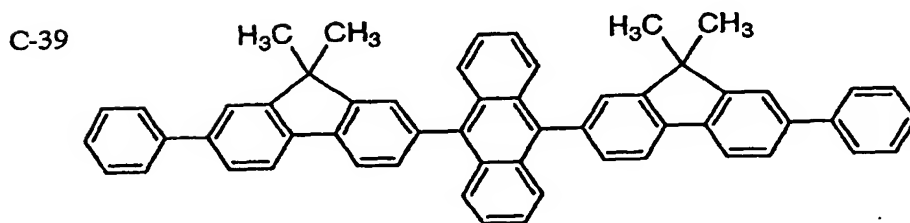
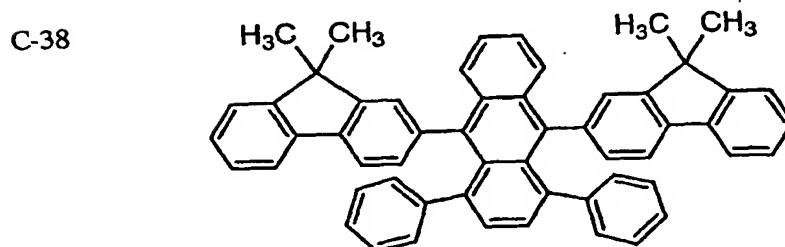
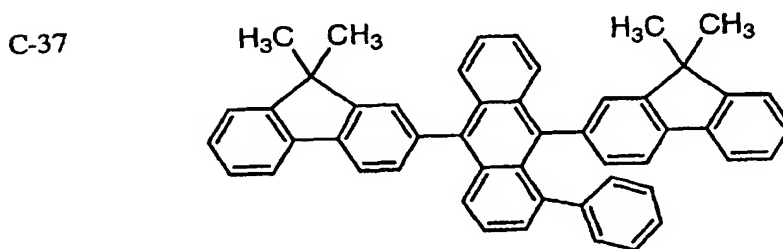
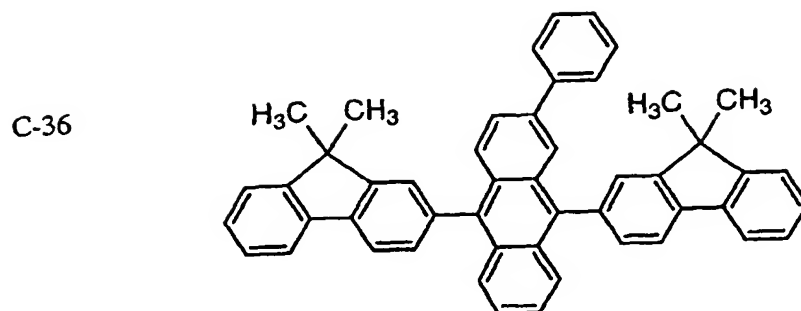


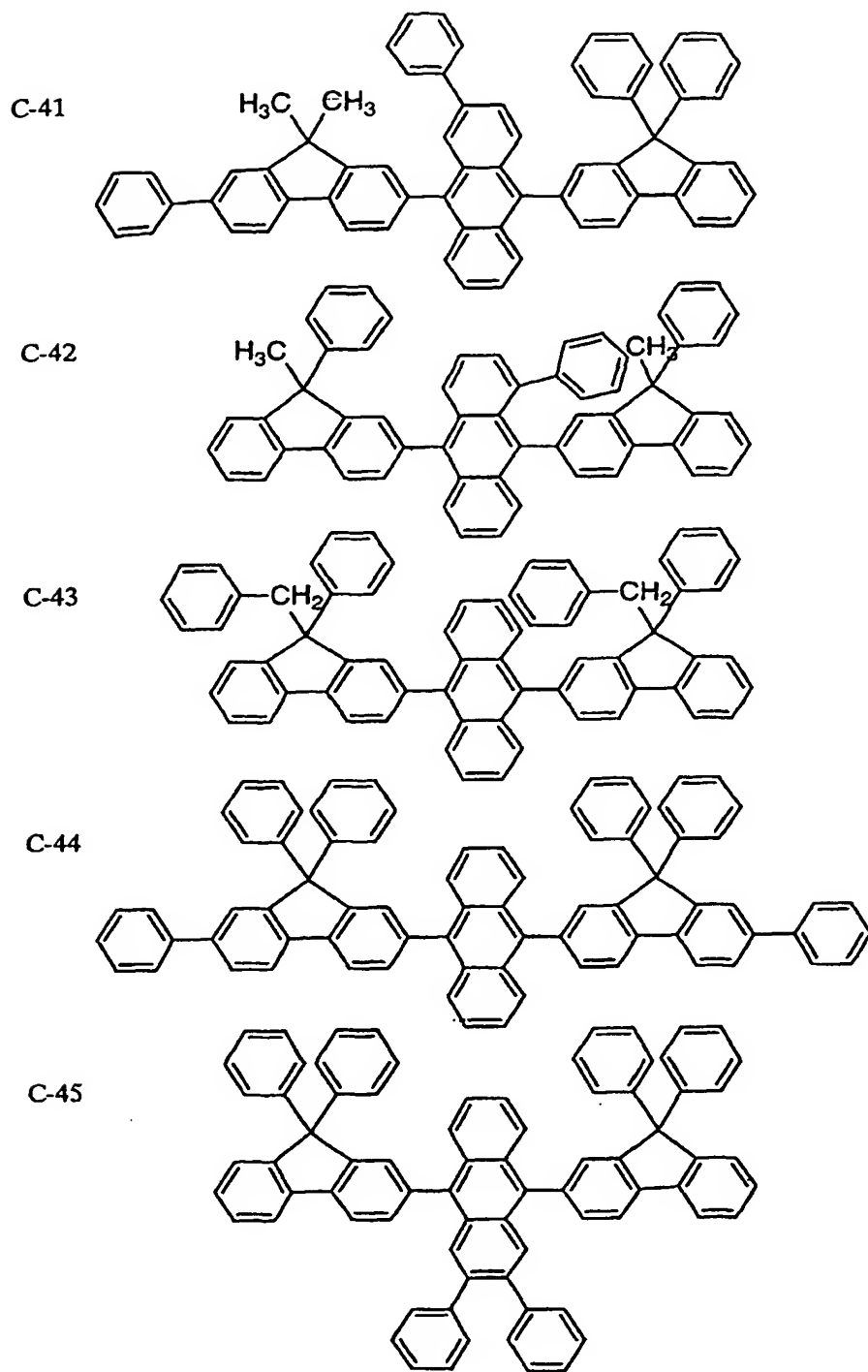
C-34



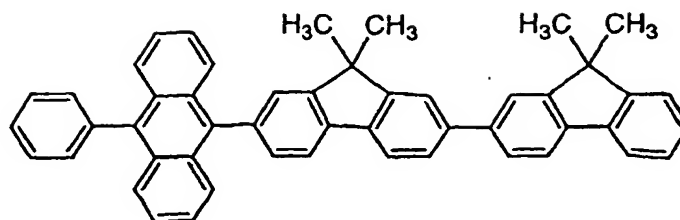
C-35



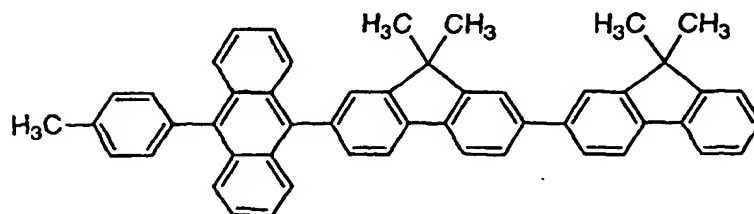




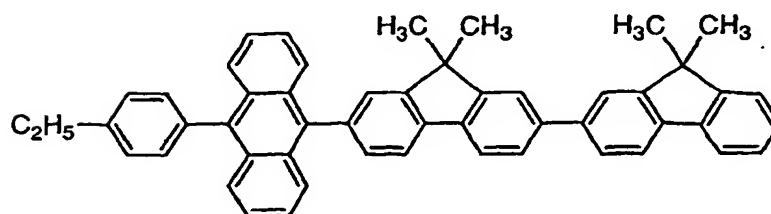
D-1



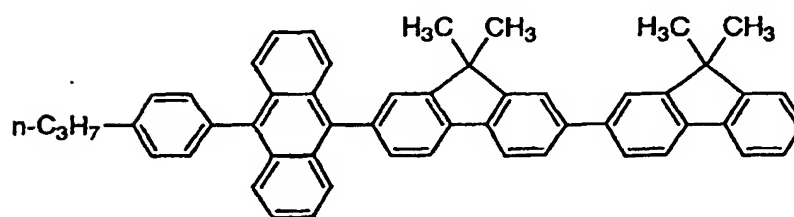
D-2



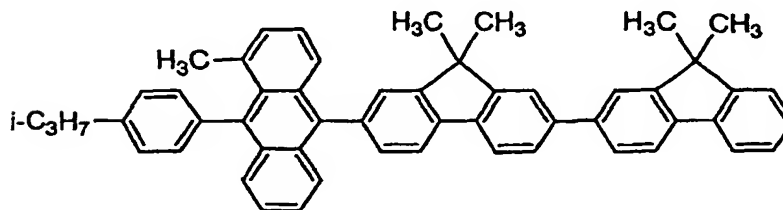
D-3



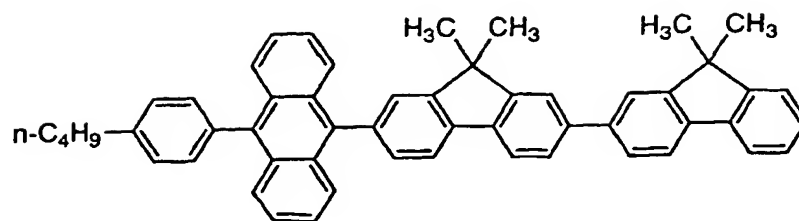
D-4



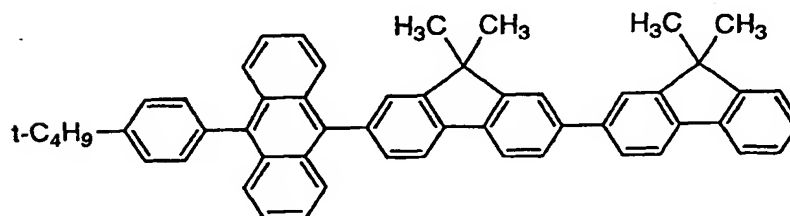
D-5



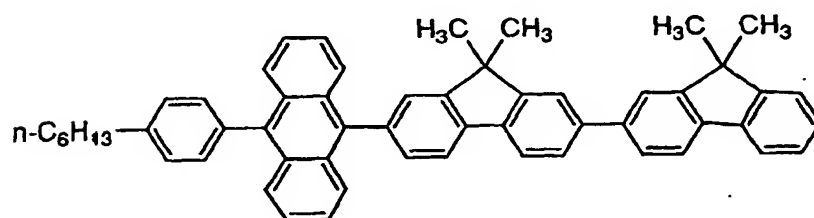
D-6



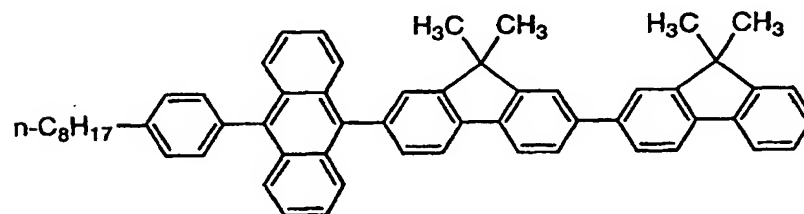
D-7



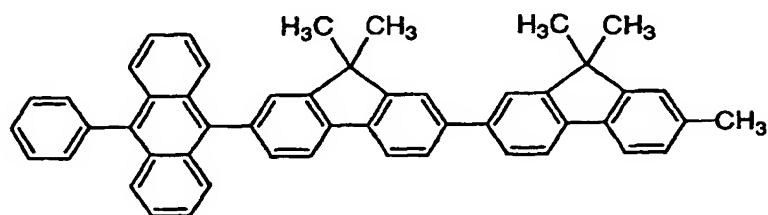
D-8



D-9



D-10



5



15



25



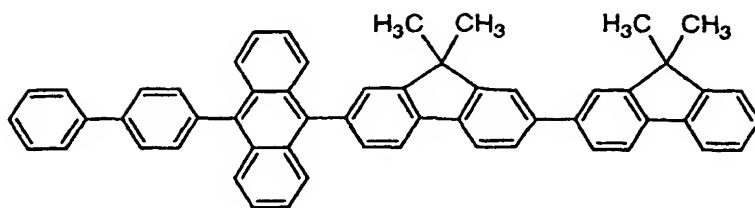
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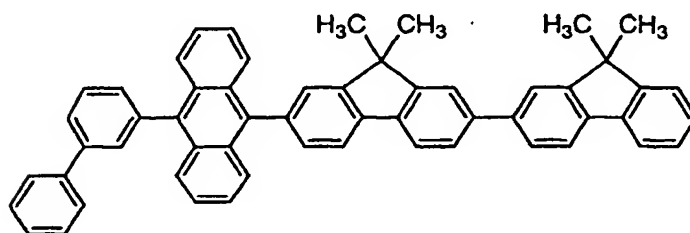
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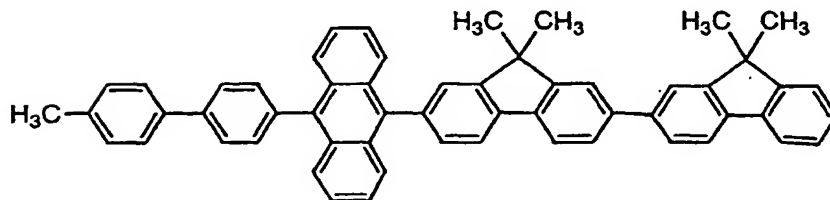
D-16



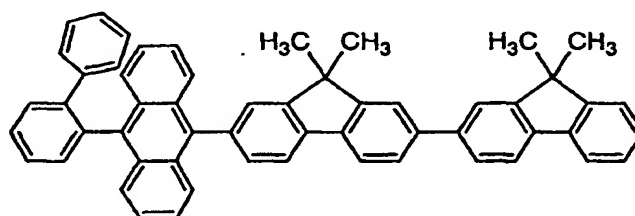
D-17



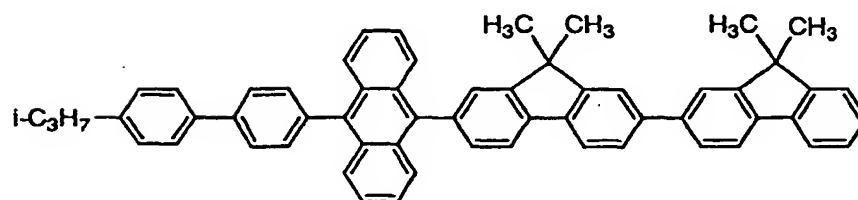
D-18



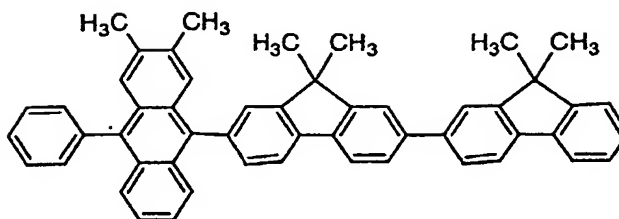
D-19



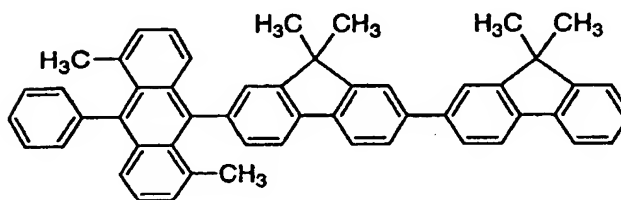
D-20



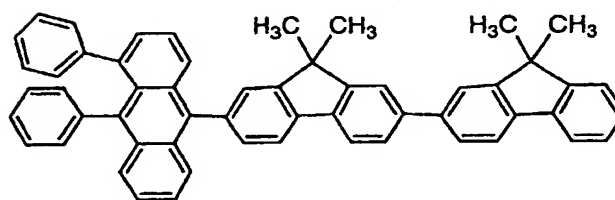
D-21



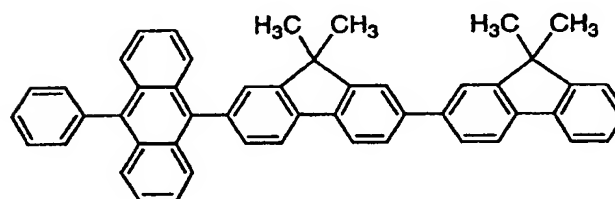
D-22



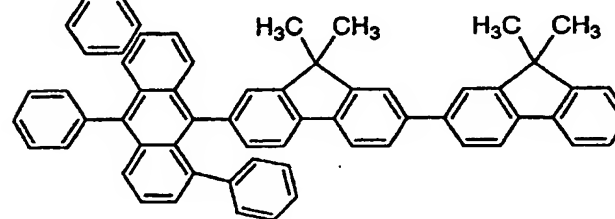
D-23



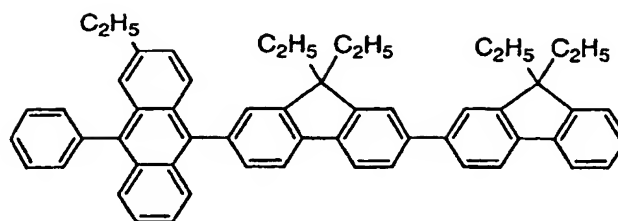
D-24



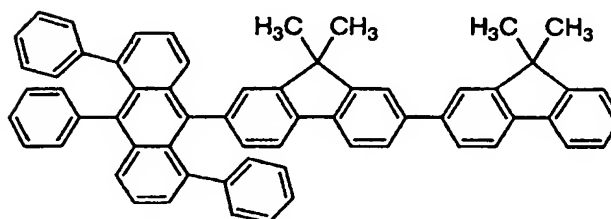
D-25



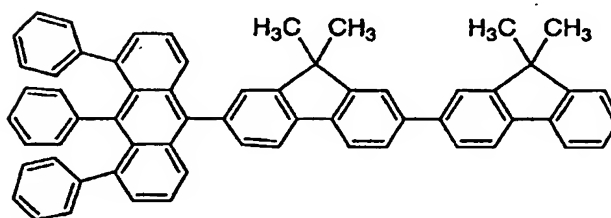
D-26



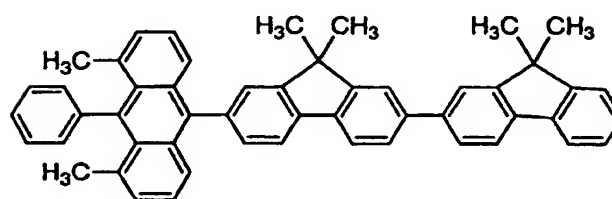
D-27



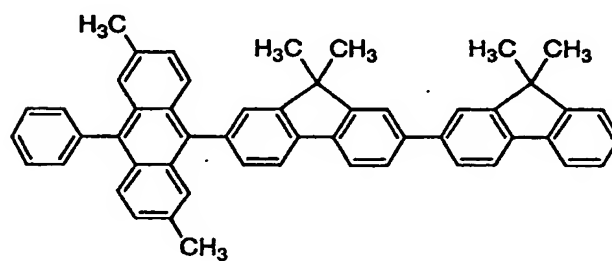
D-28



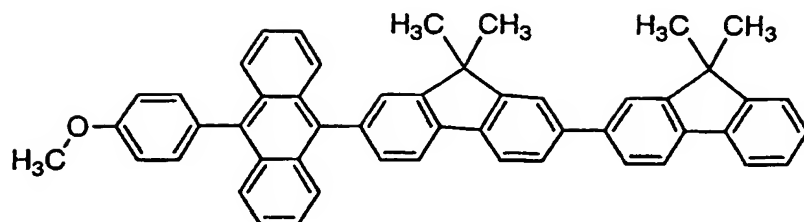
D-29



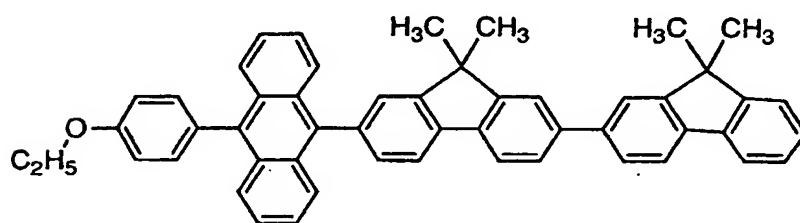
D-30



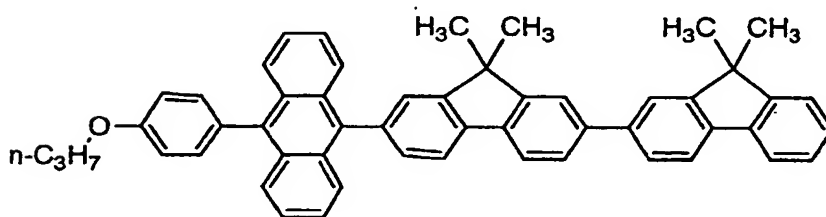
D-31



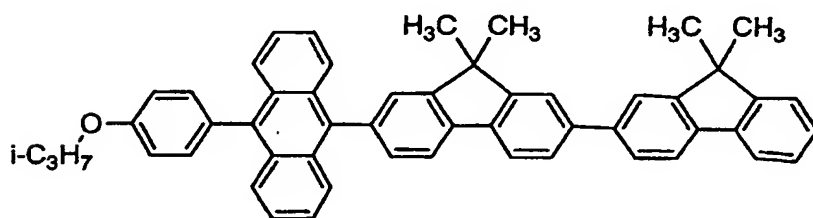
D-32



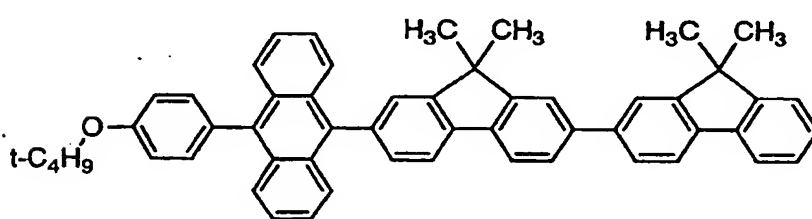
D-33



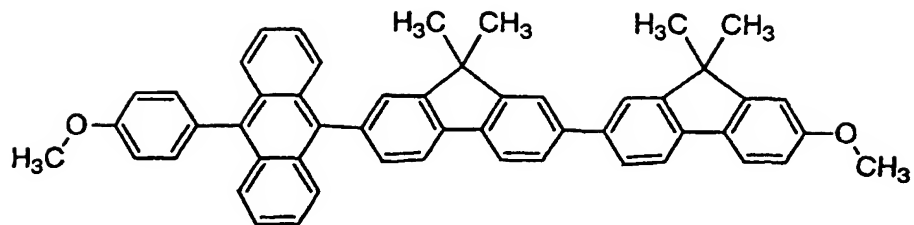
D-34



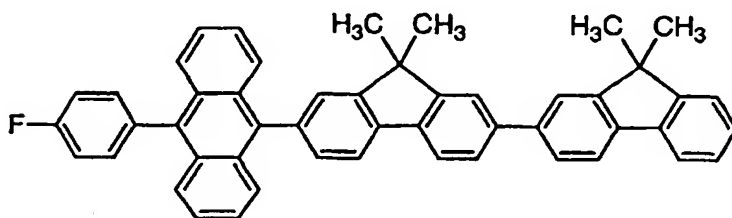
D-35



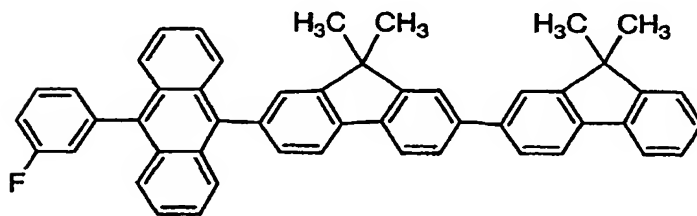
D-36



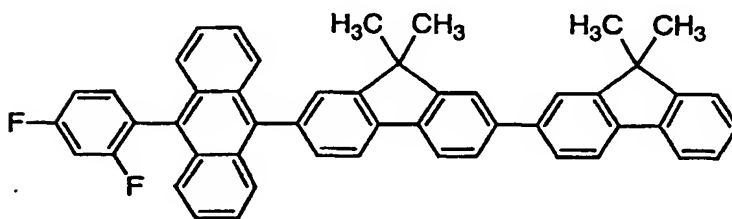
D-37



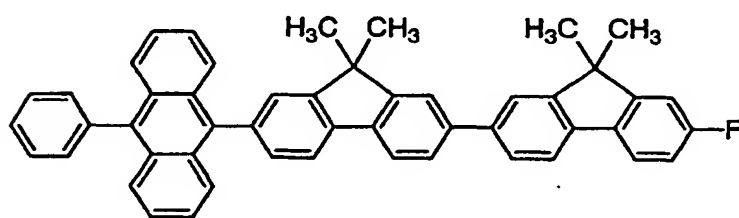
D-38



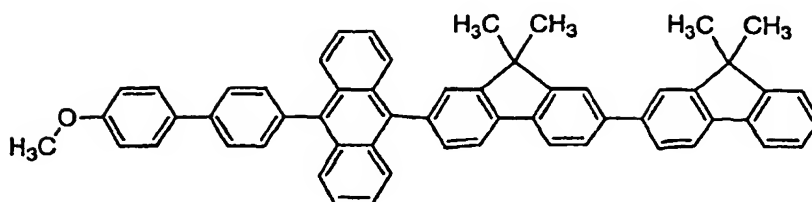
D-39



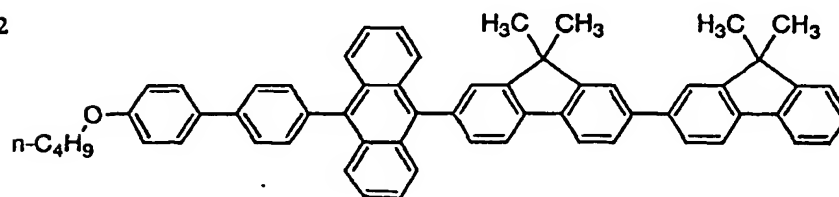
D-40



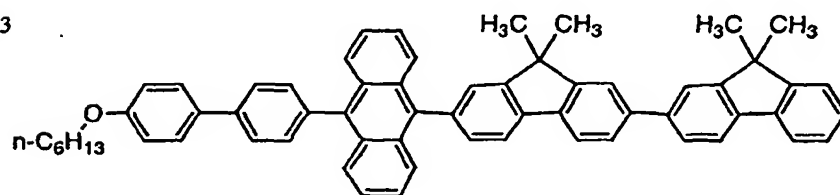
D-41



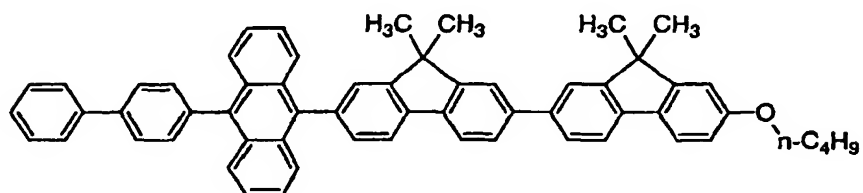
D-42



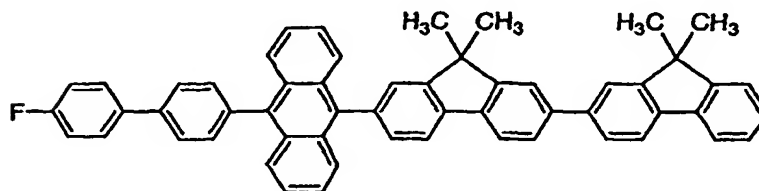
D-43



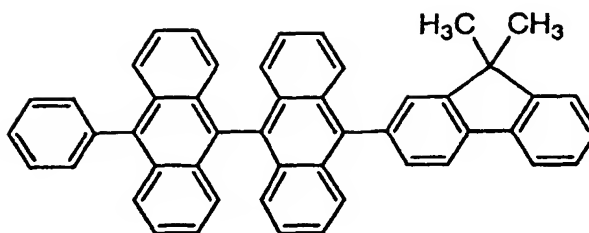
D-44



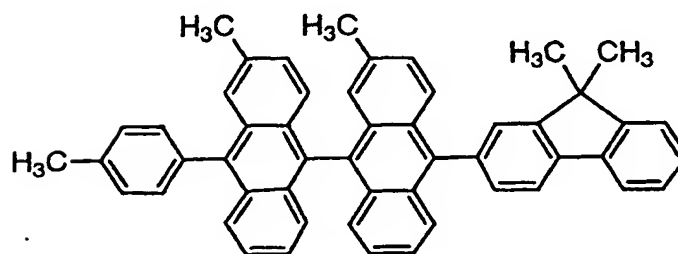
D-45



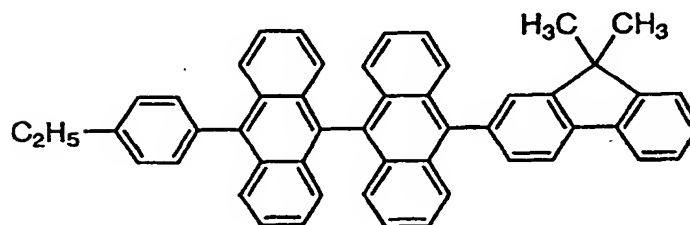
E-1



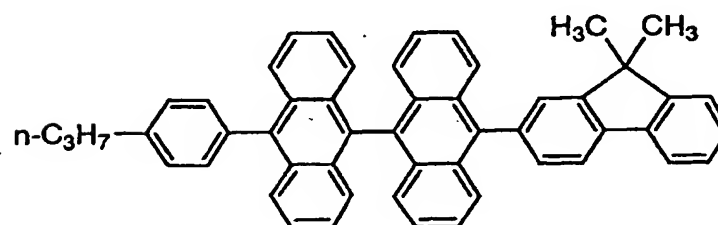
E-2



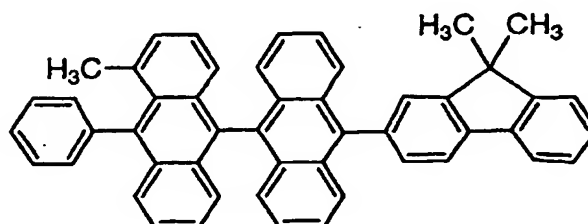
E-3



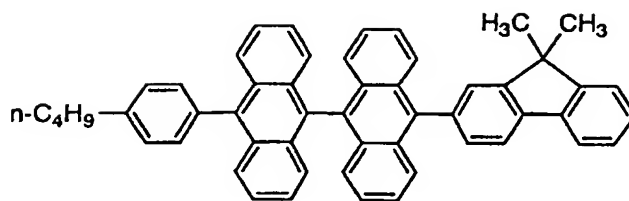
E-4



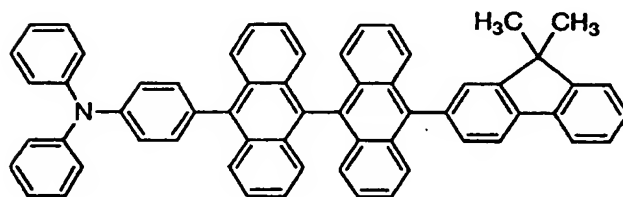
E-5



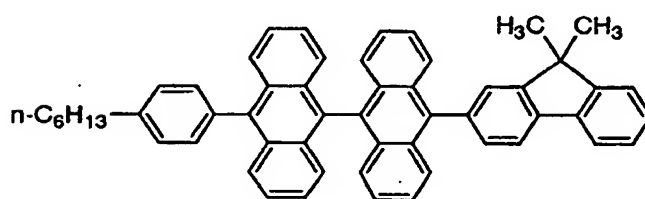
E-6



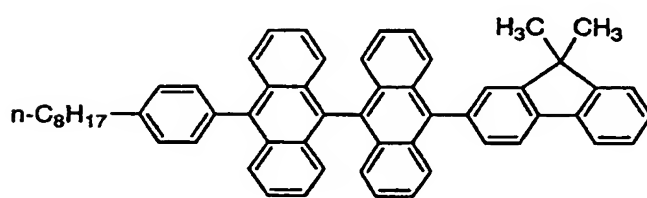
E-7



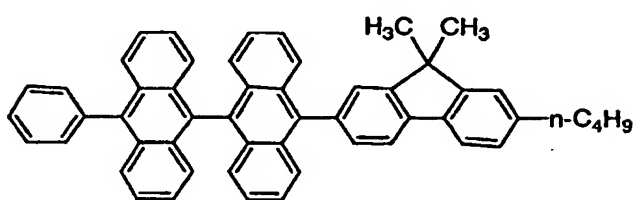
E-8



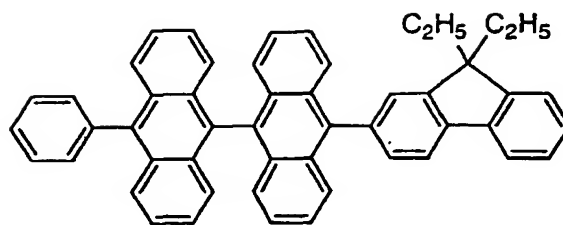
E-9



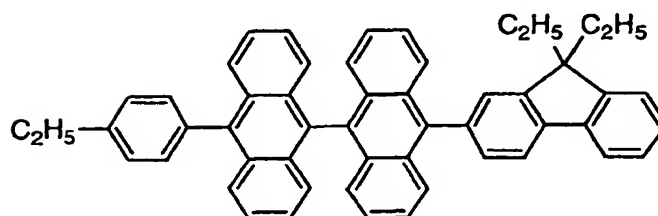
E-10



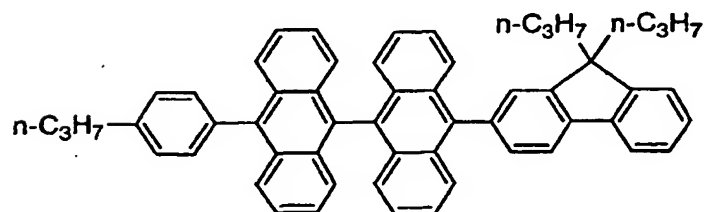
E-11



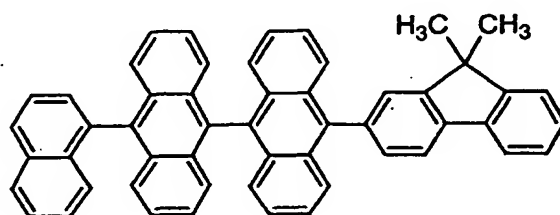
E-12



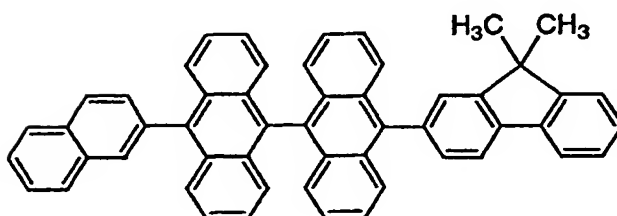
E-13



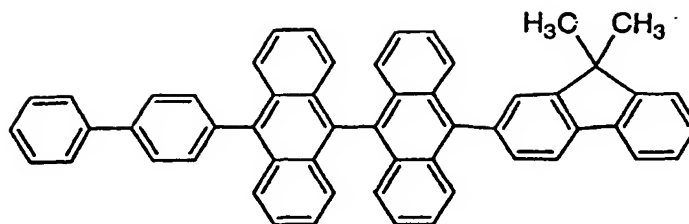
E-14



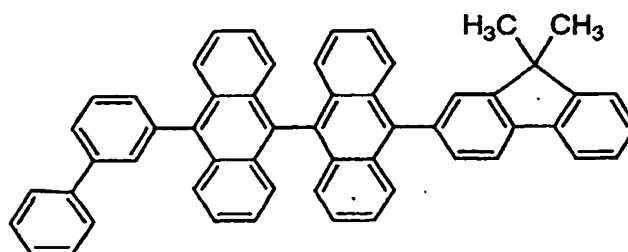
E-15



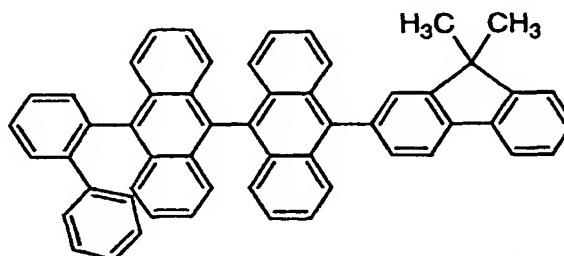
E-16



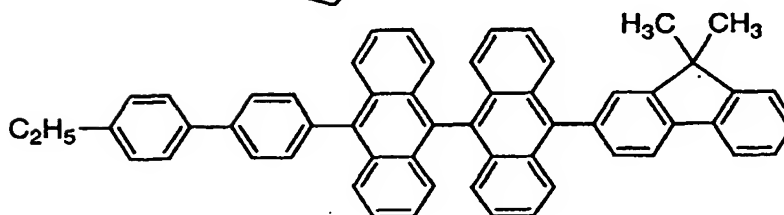
E-17



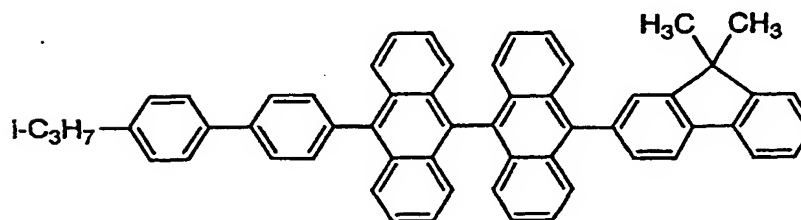
E-18



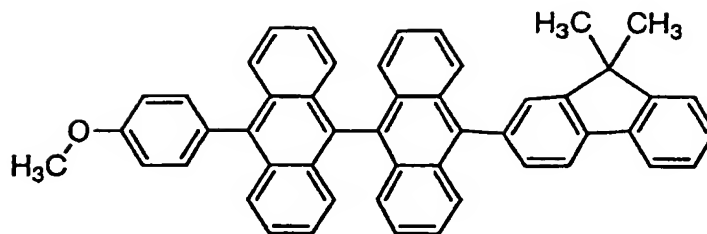
E-19



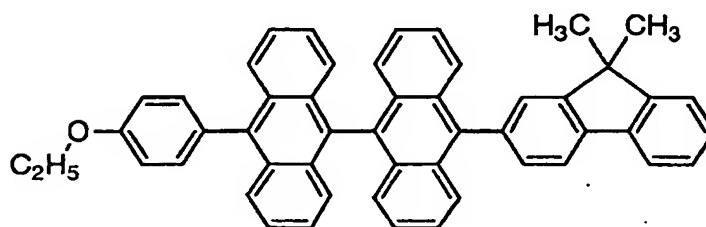
E-20



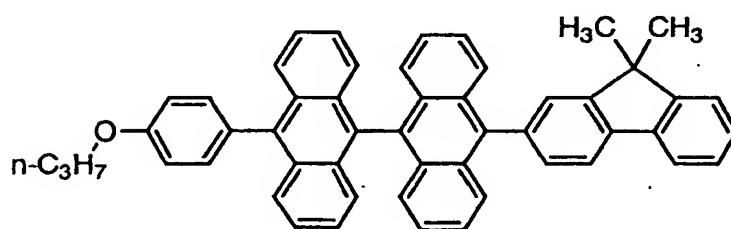
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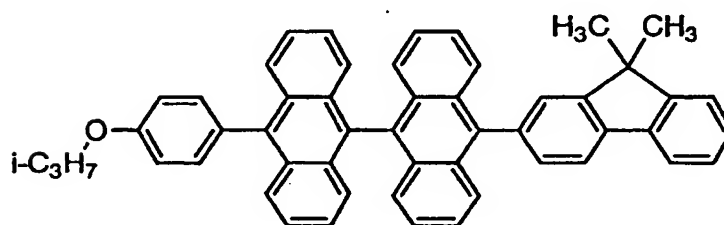
E-22



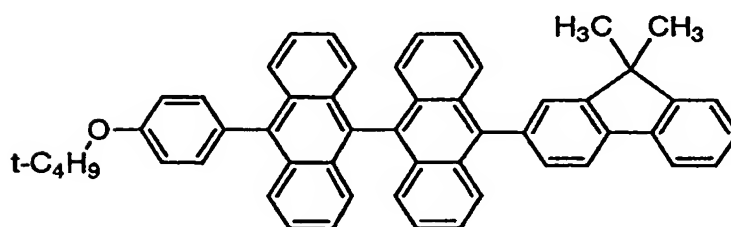
E-23



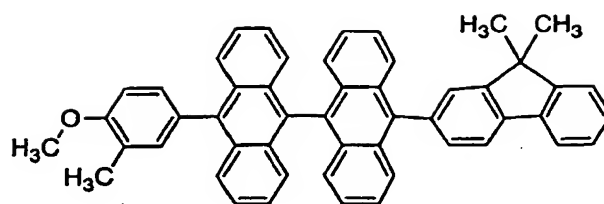
E-24



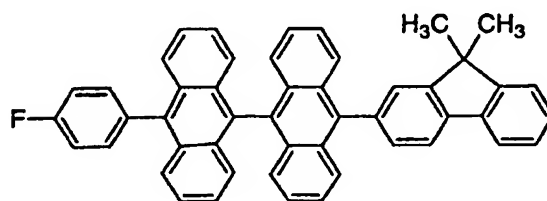
E-25



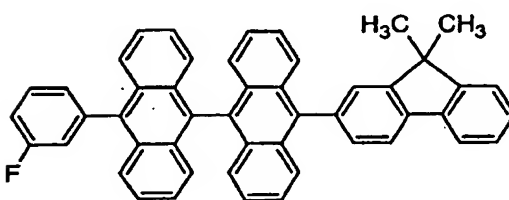
E-26



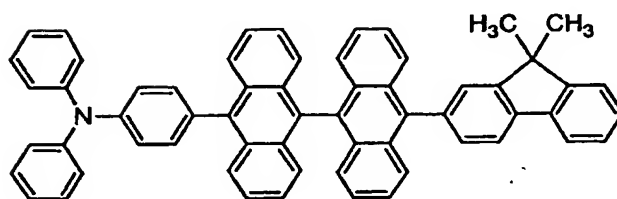
E-27



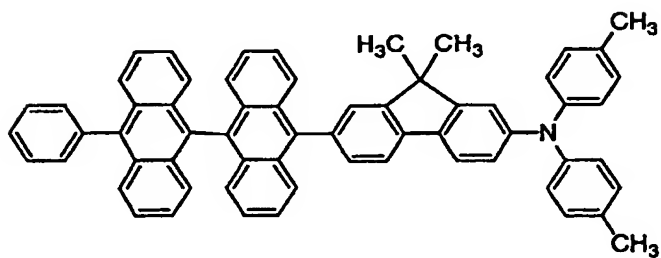
E-28



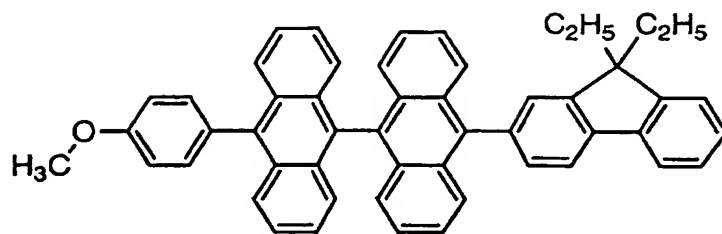
E-29



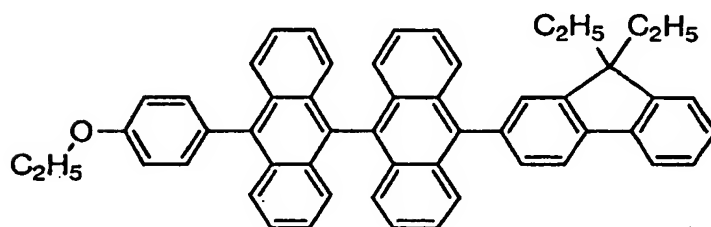
E-30



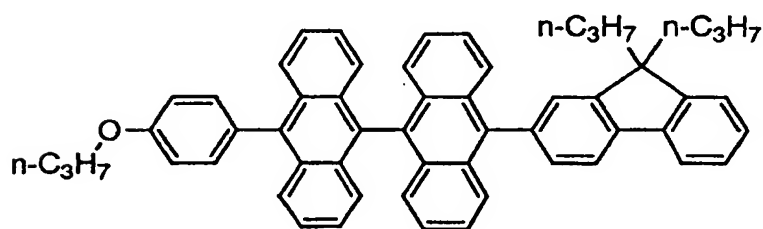
E-31



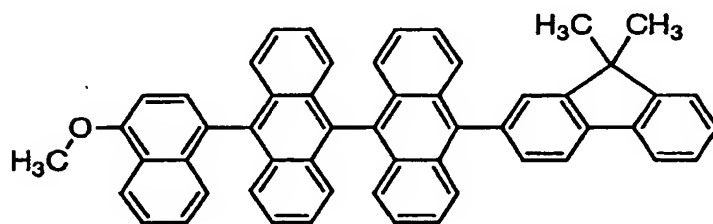
E-32



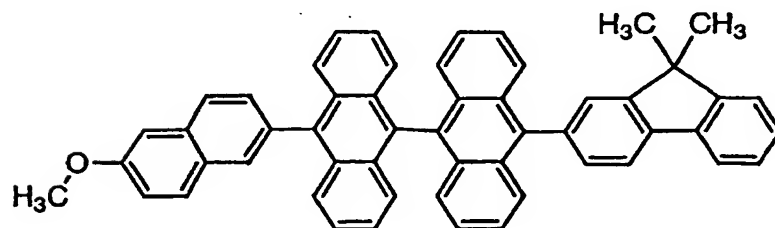
E-33



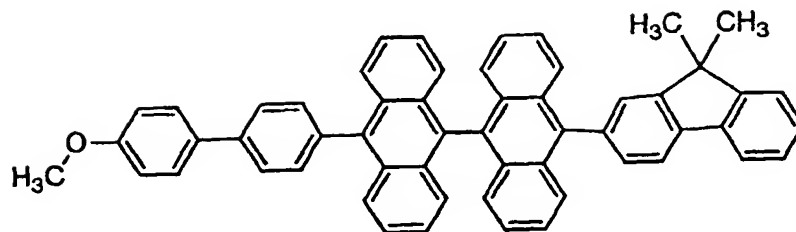
E-34



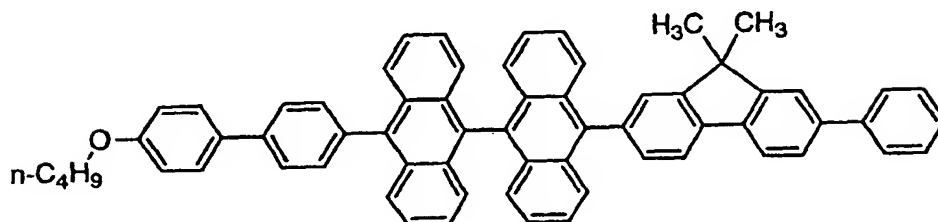
E-35



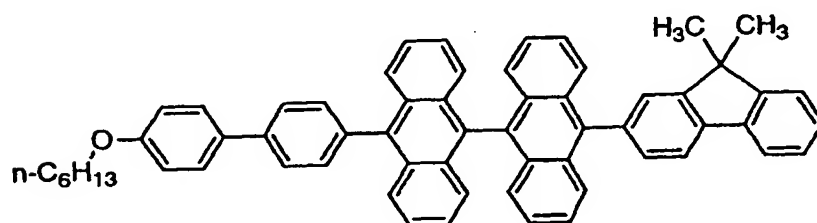
E-36



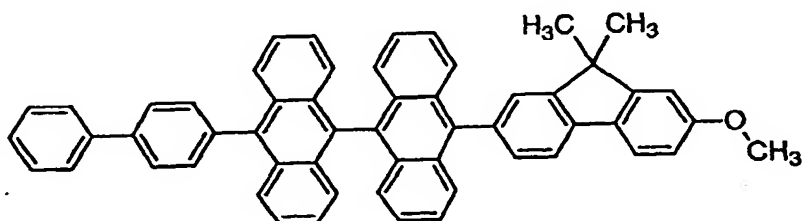
E-37



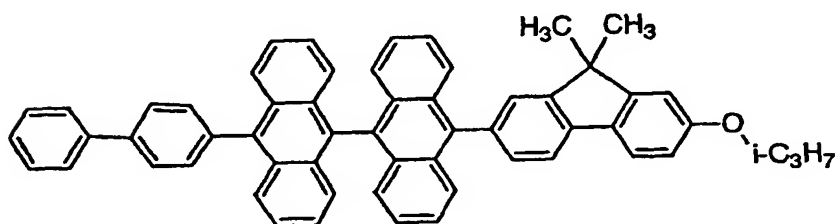
E-38

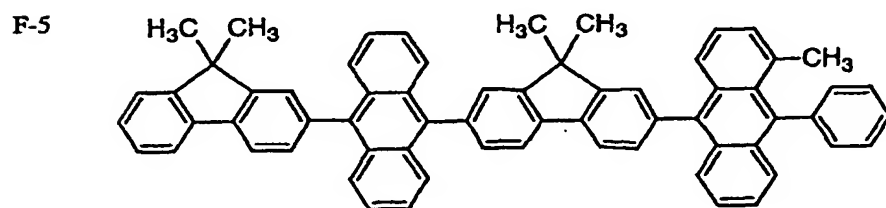
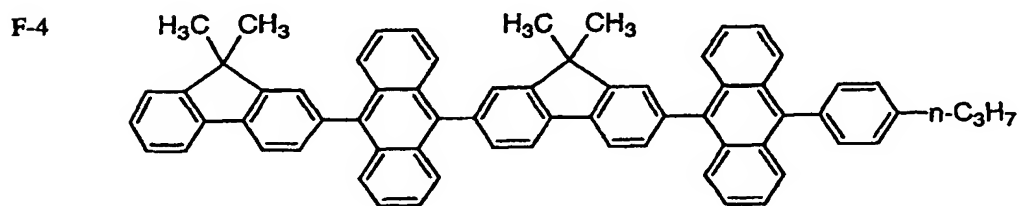
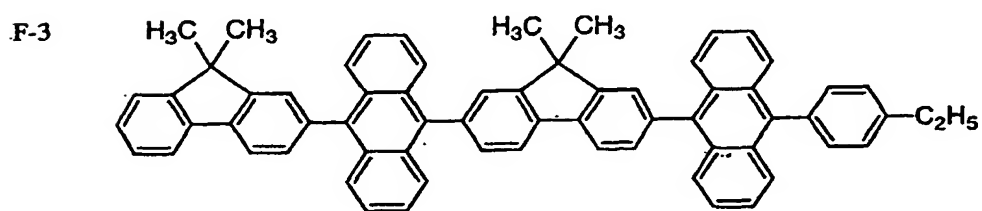
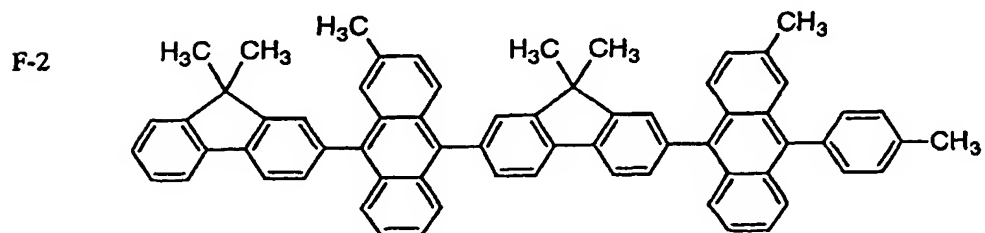
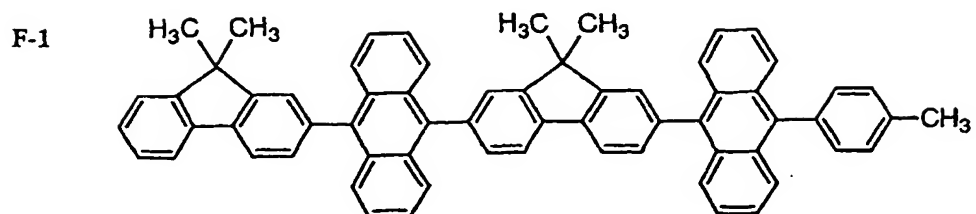


E-39

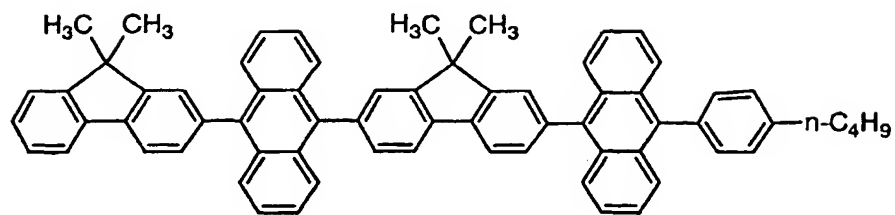


E-40

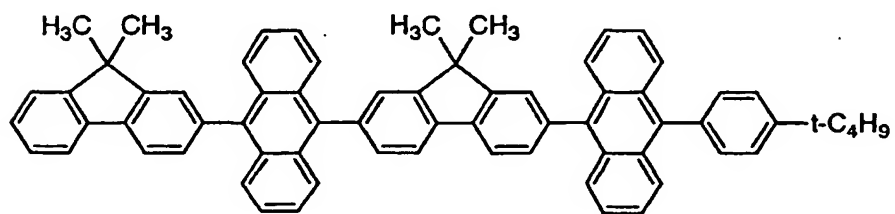




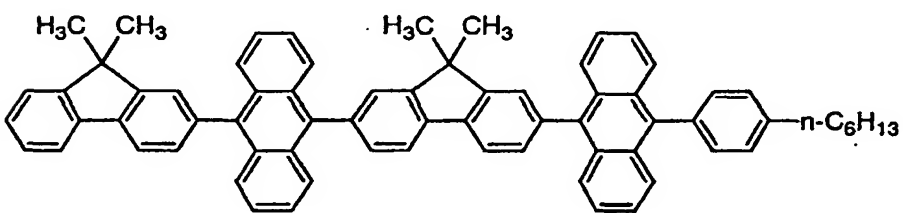
F-6



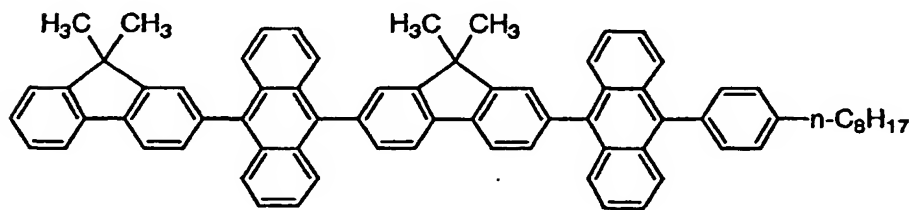
F-7



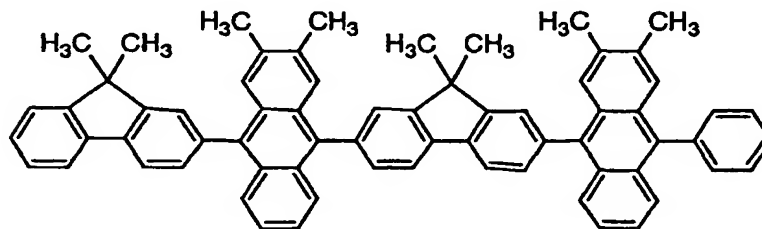
F-8



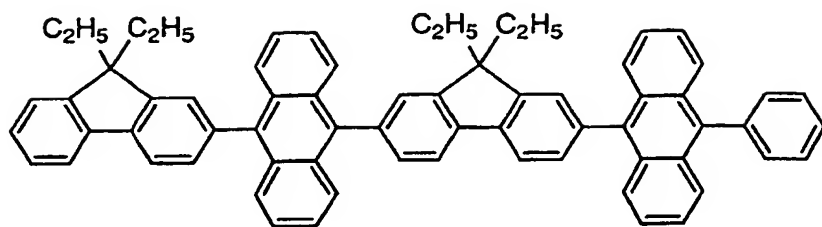
F-9



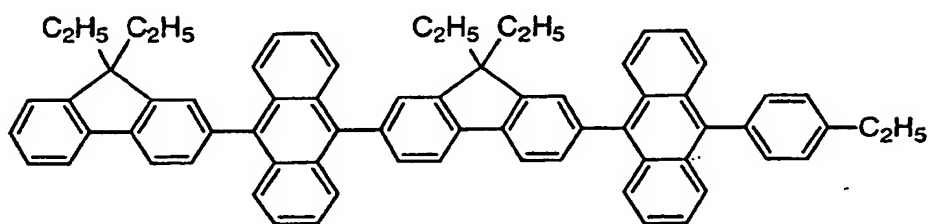
F-10



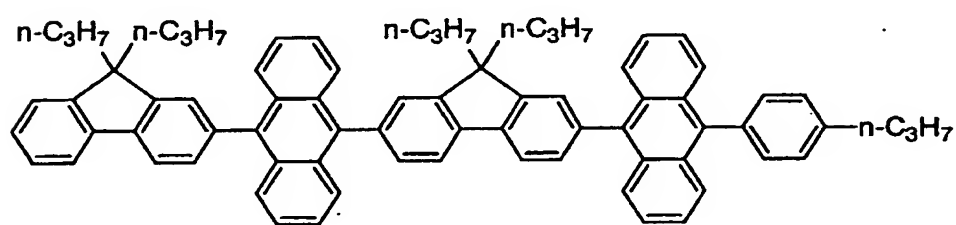
F-11



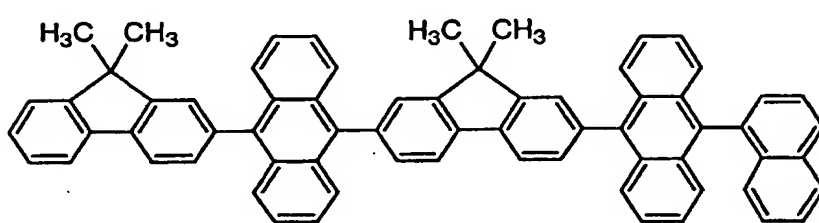
F-12



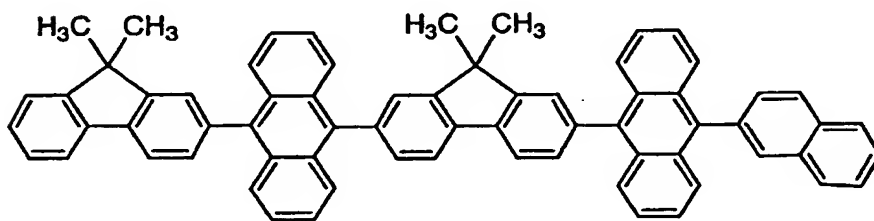
F-13



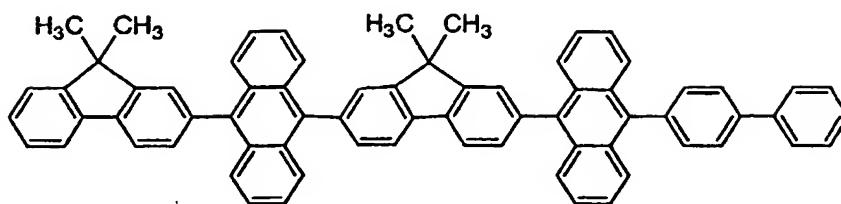
F-14



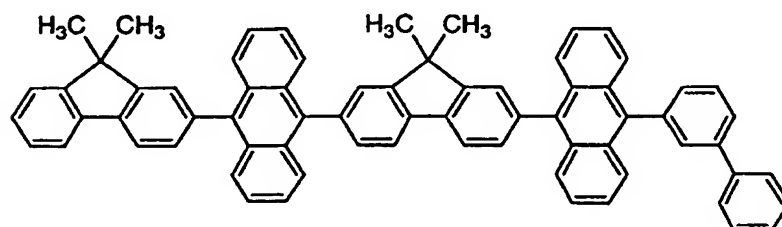
F-15



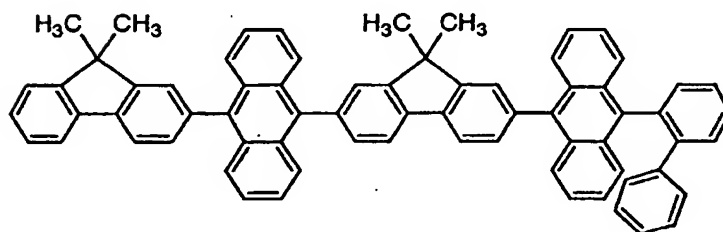
F-16



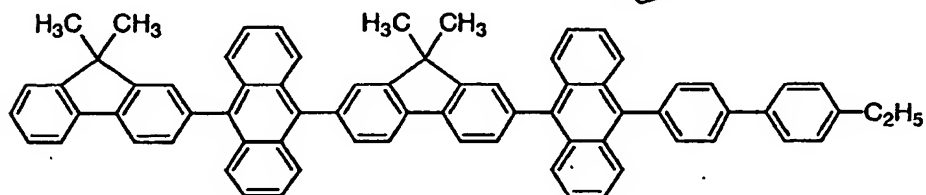
F-17



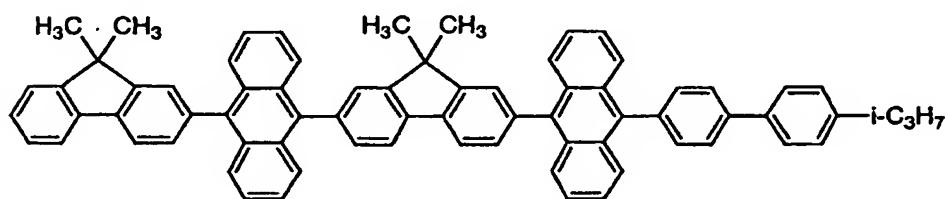
F-18



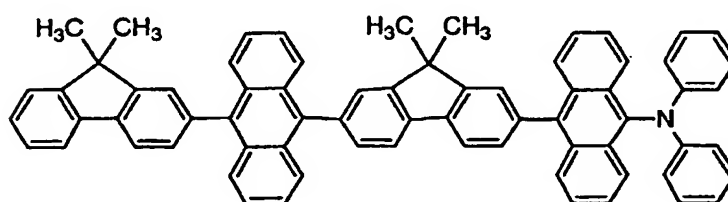
F-19



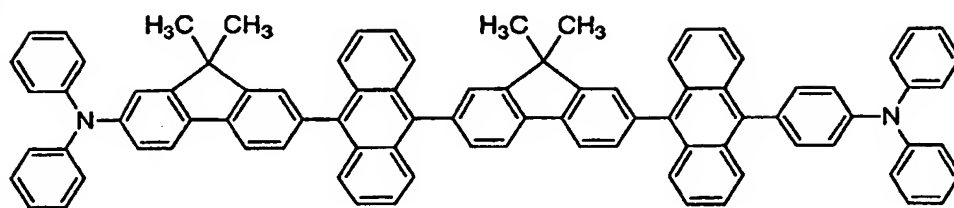
F-20



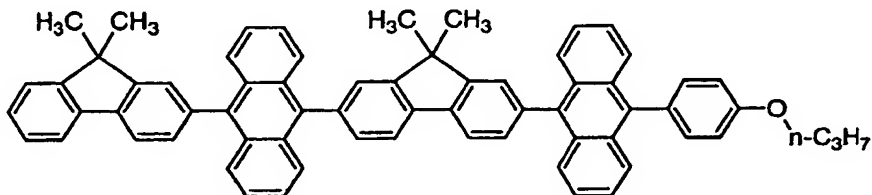
F-21



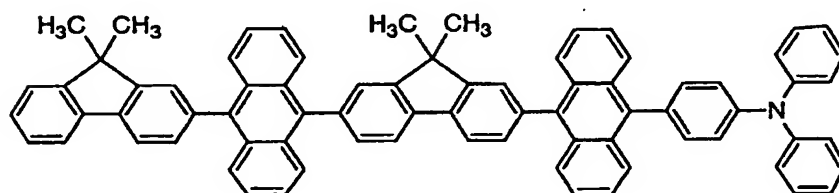
F-22



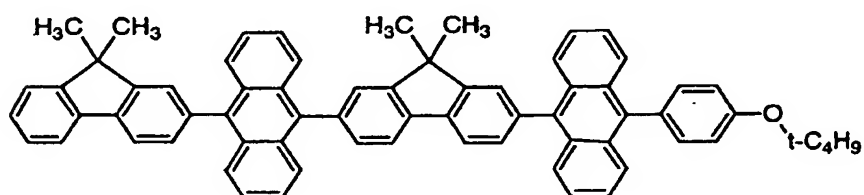
F-23



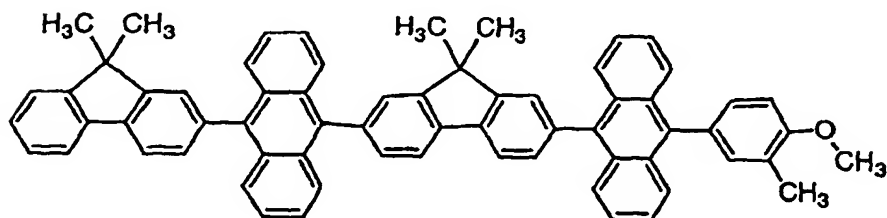
F-24



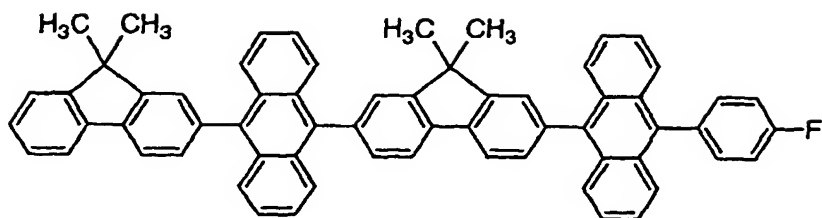
F-25



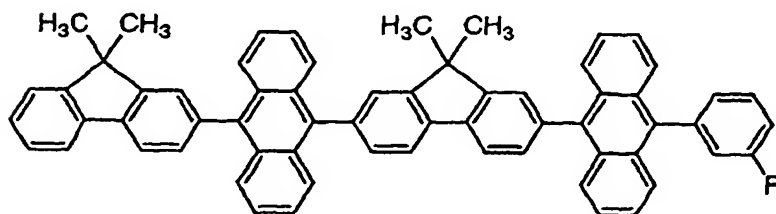
F-26



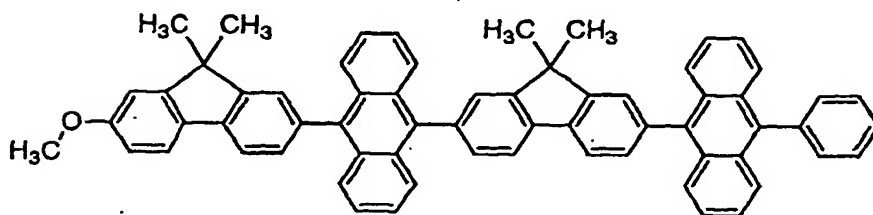
F-27



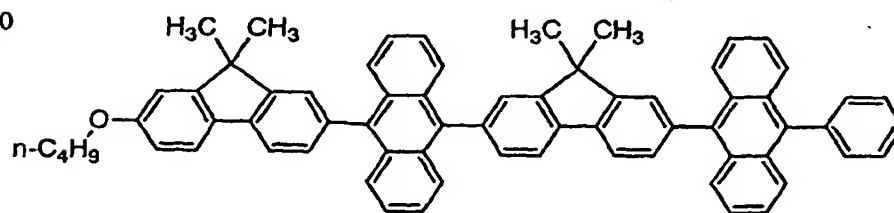
F-28



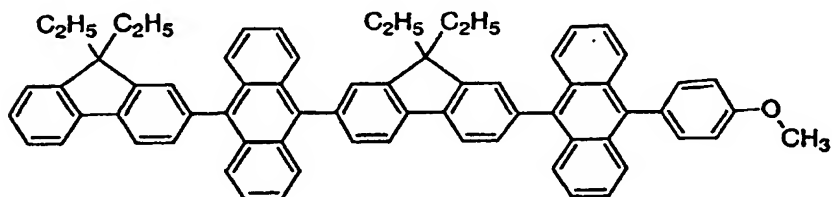
F-29



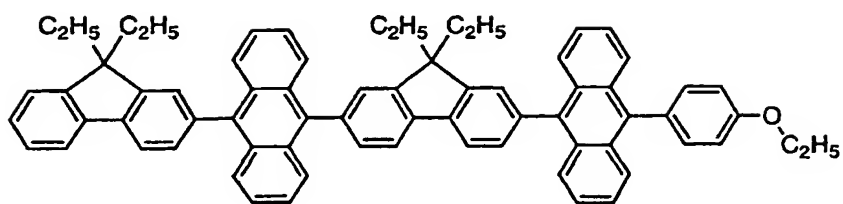
F-30



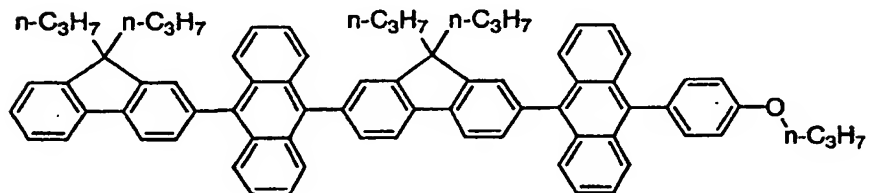
F-31



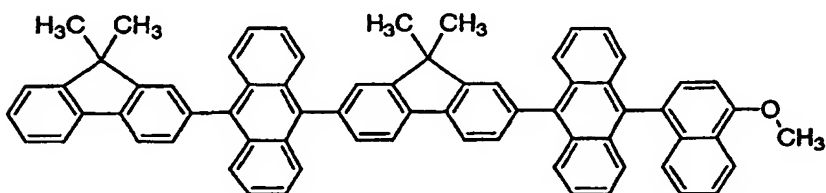
F-32



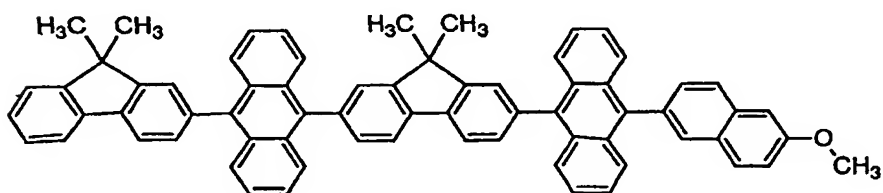
F-33



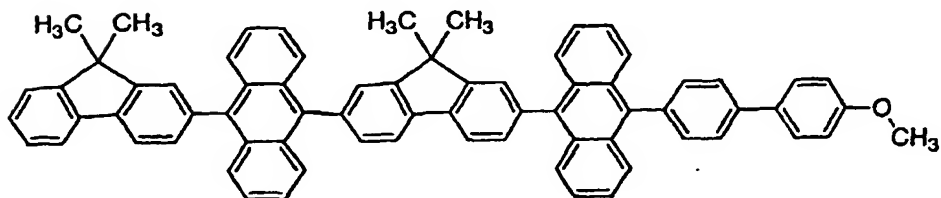
F-34



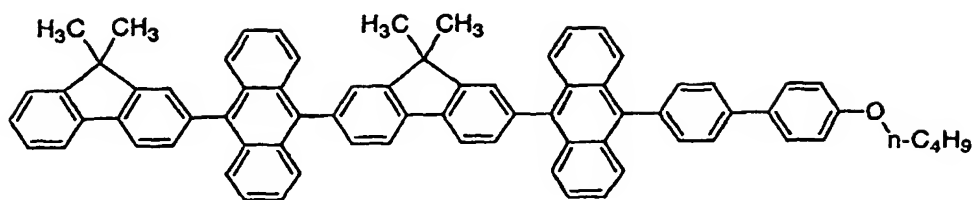
F-35



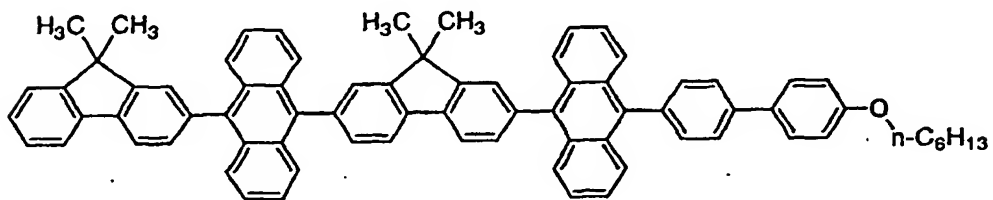
F-36



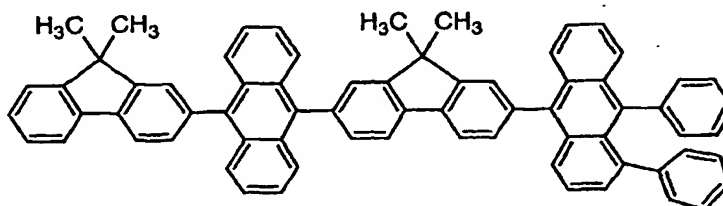
F-37



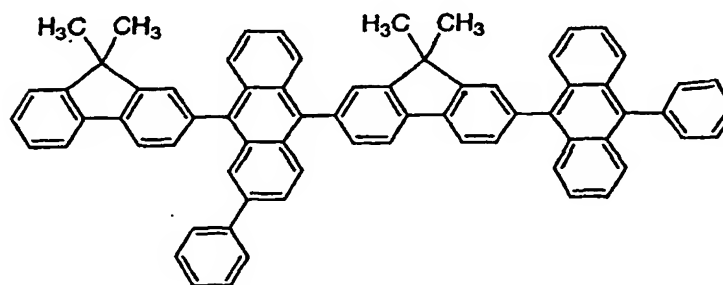
F-38



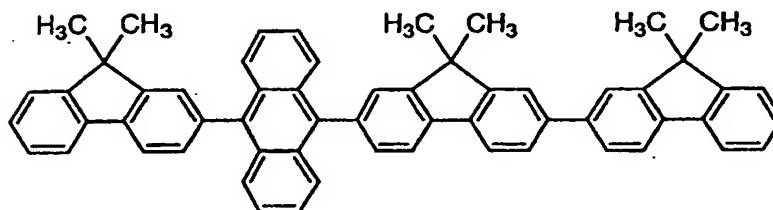
F-39



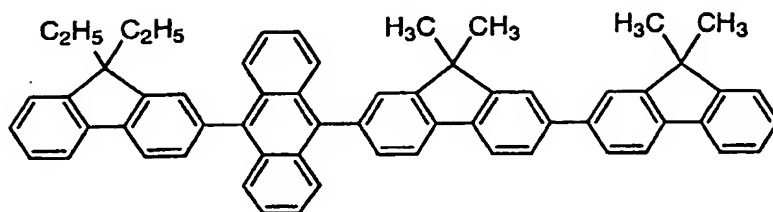
F-40



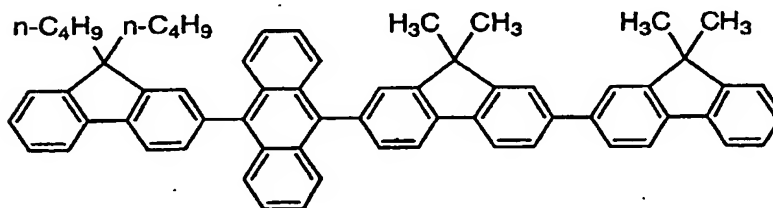
G-1



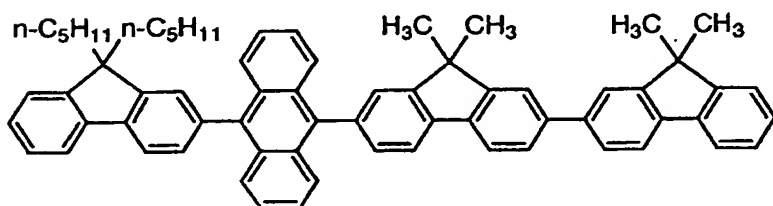
G-2



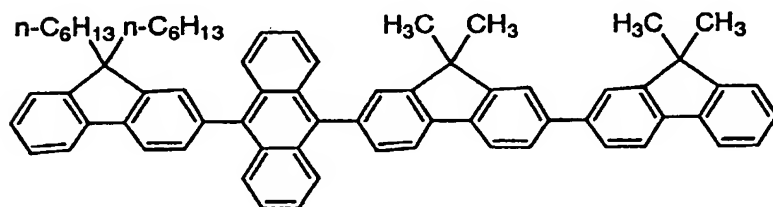
G-3



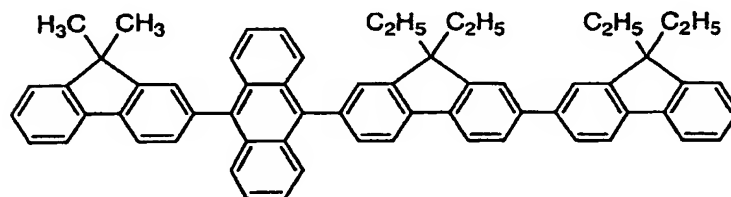
G-4



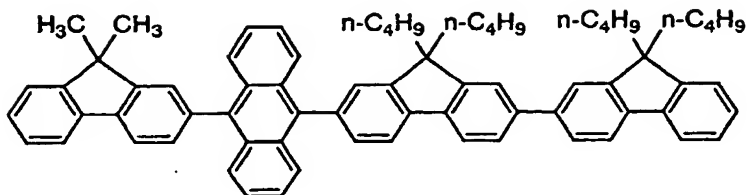
G-5



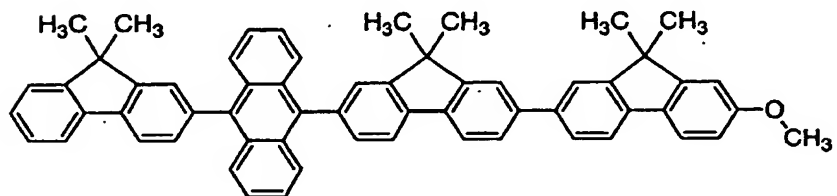
G-6



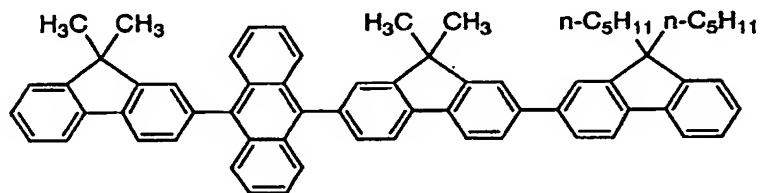
G-7



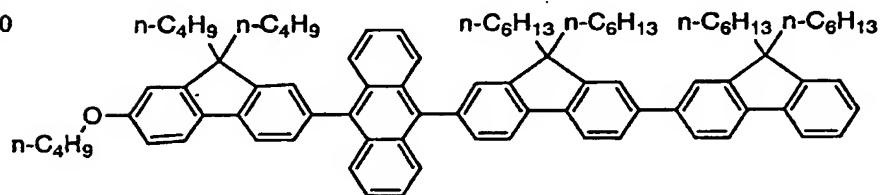
G-8



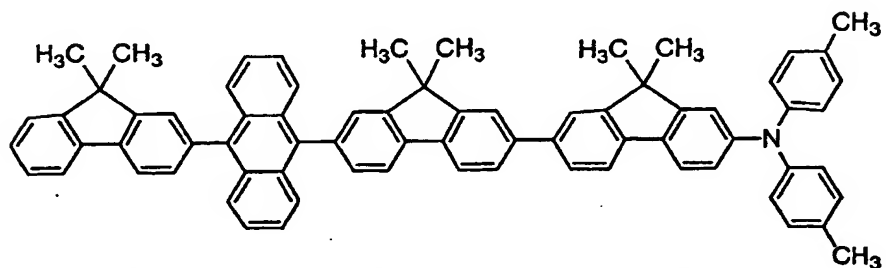
G-9



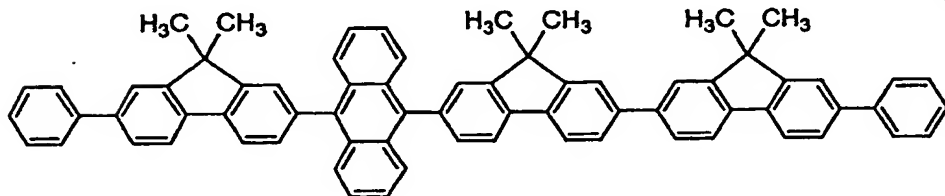
G-10

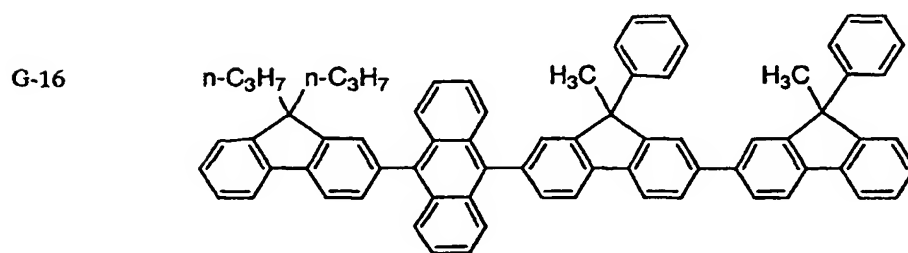
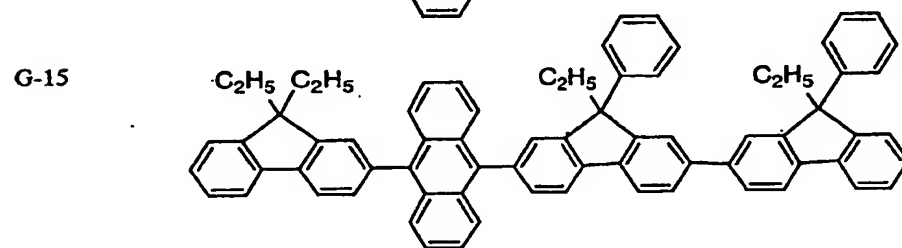
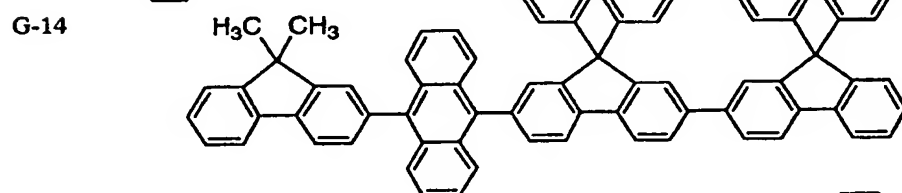
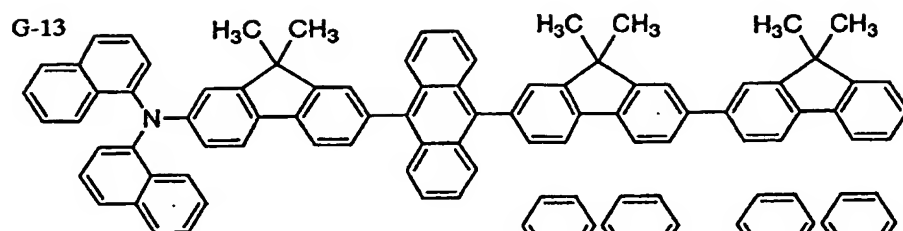


G-11

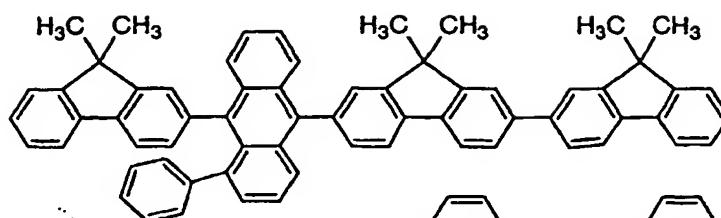


G-12

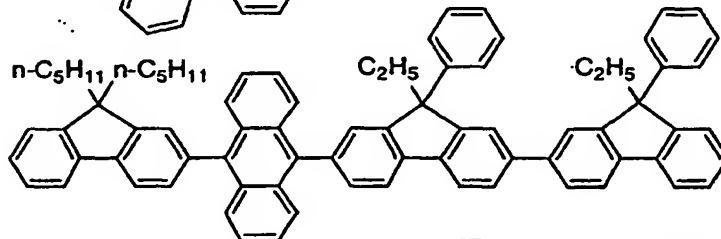




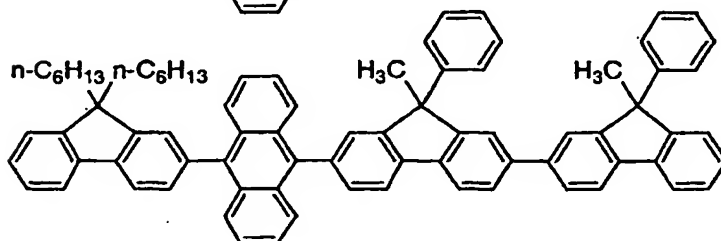
G-17



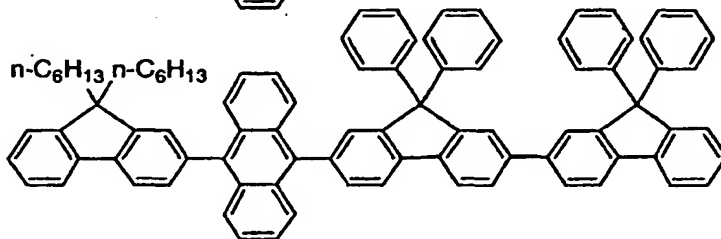
G-18



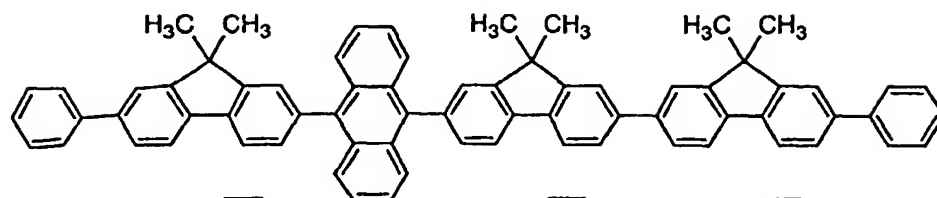
G-19



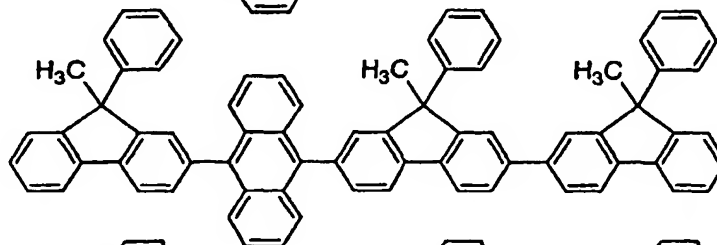
G-20



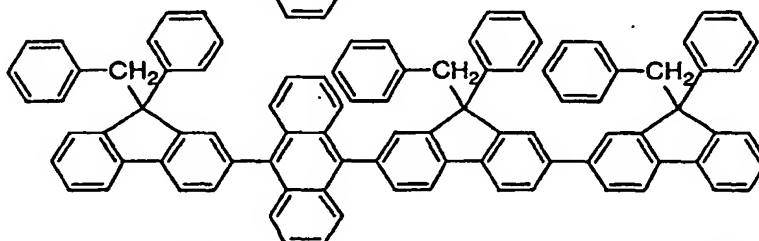
G-21



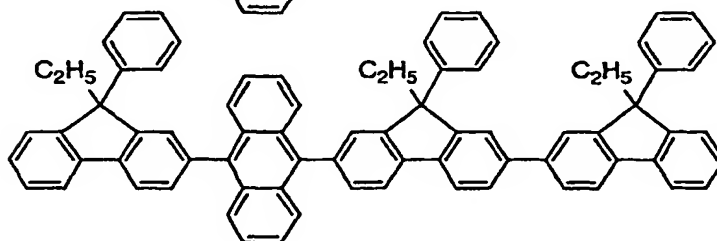
G-22



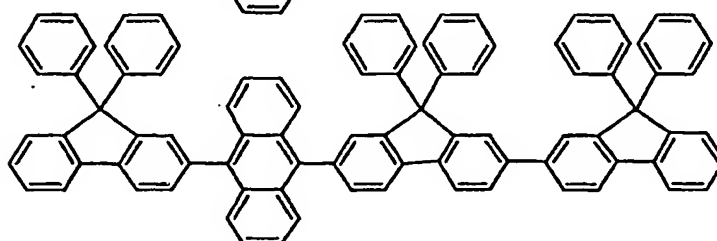
G-23



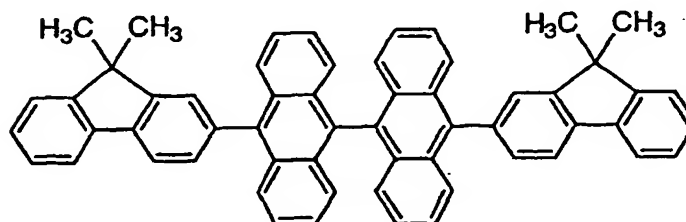
G-24



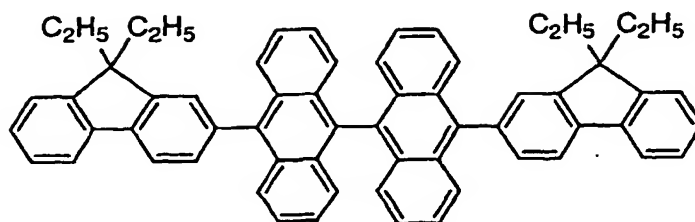
G-25



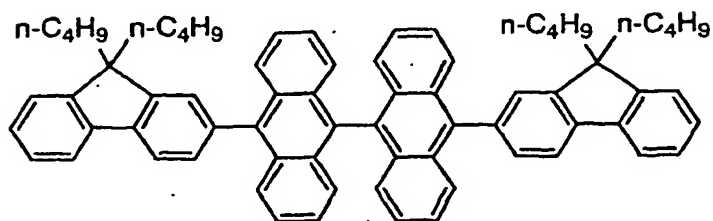
H-1



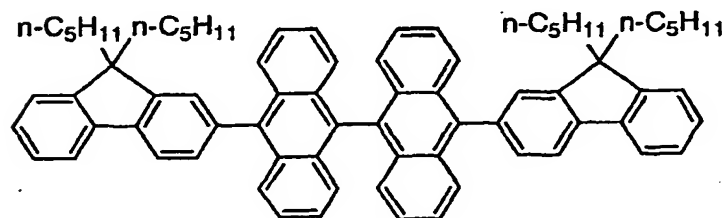
H-2



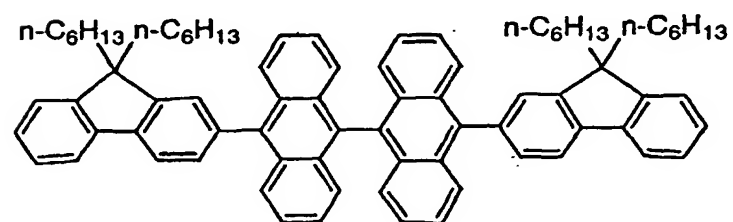
H-3



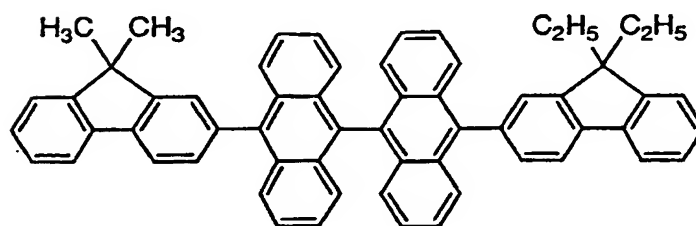
H-4



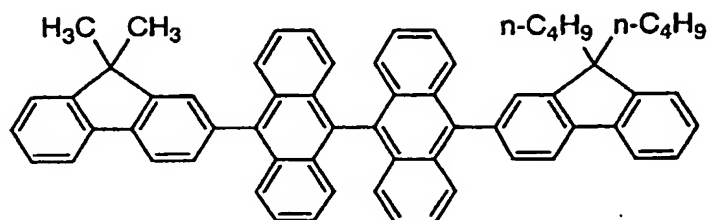
H-5



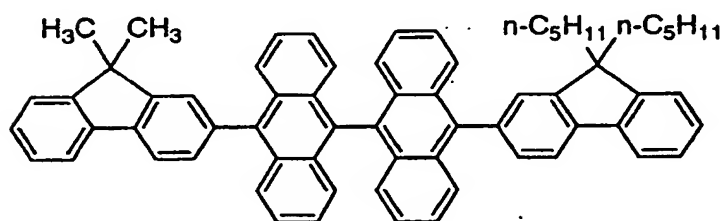
H-6



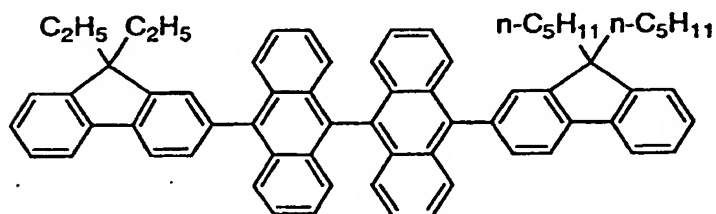
H-7



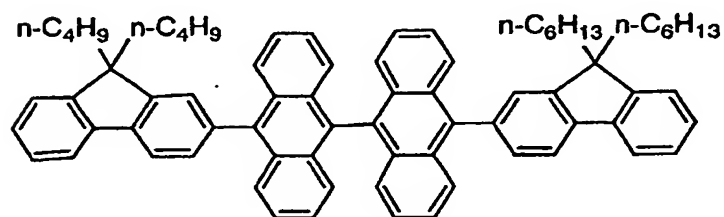
H-8



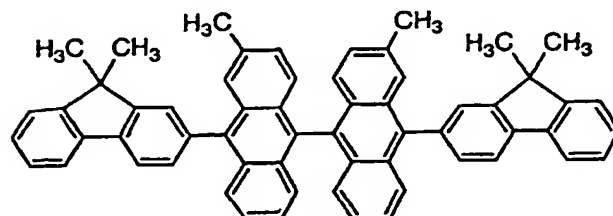
H-9



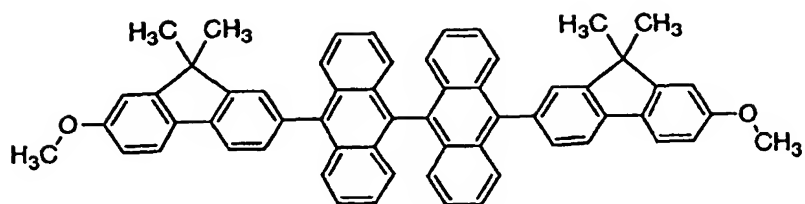
H-10



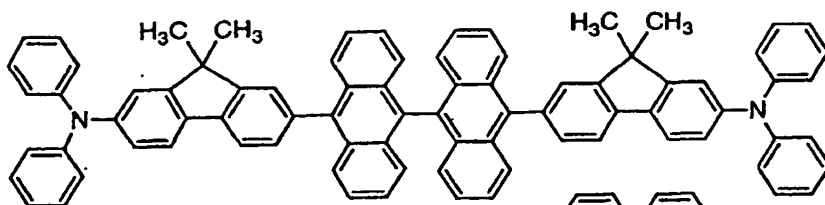
H-11



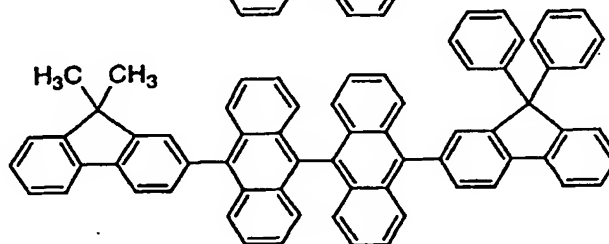
H-12



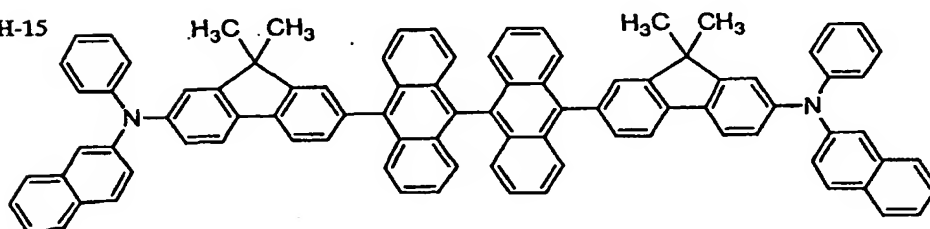
H-13



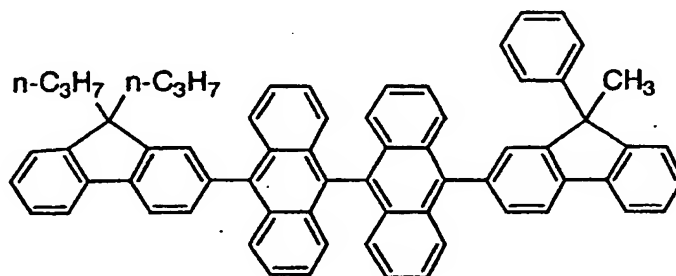
H-14



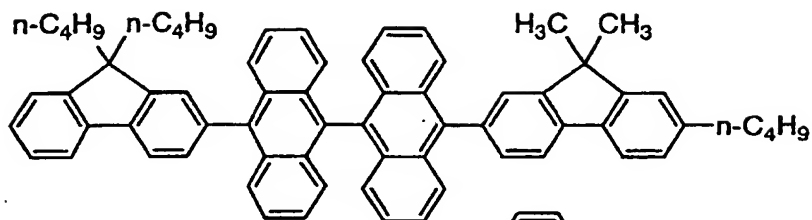
H-15



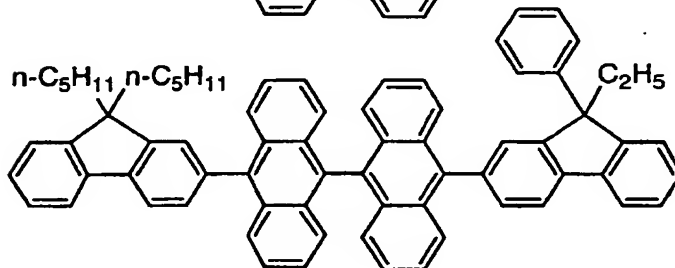
H-16



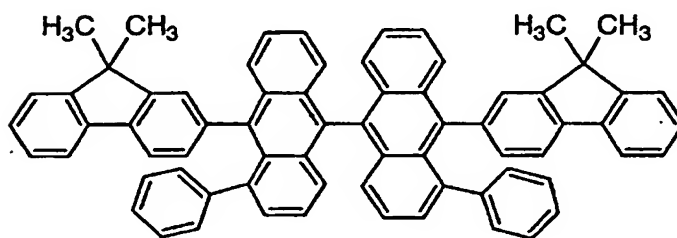
H-17



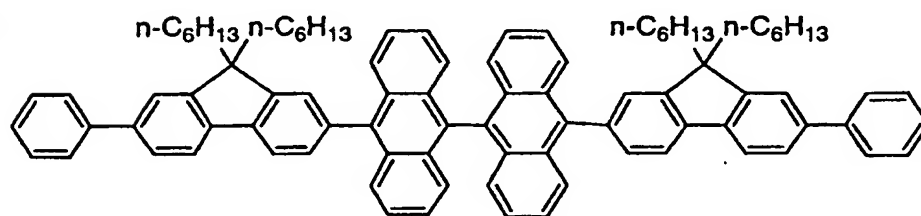
H-18



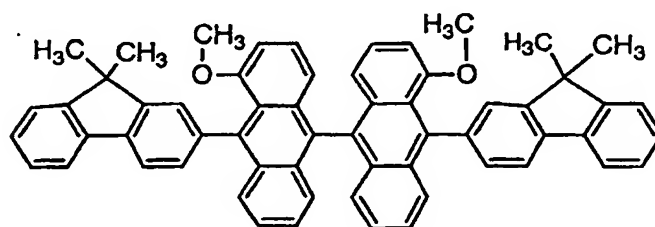
H-19



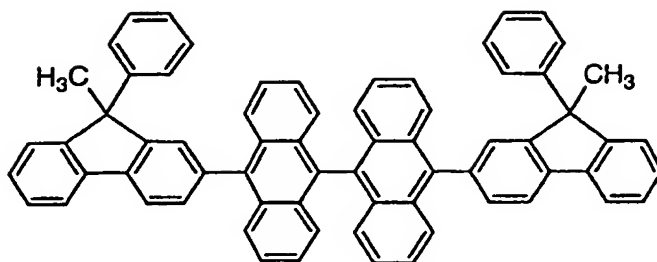
H-20



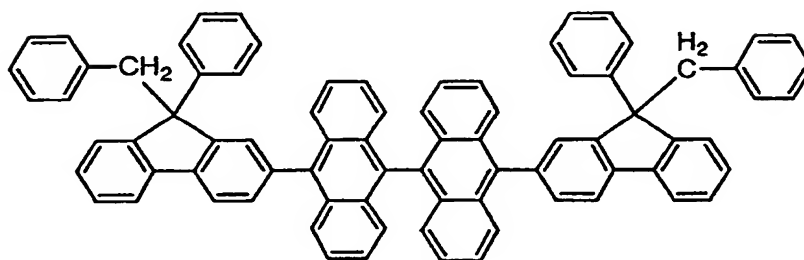
H-21



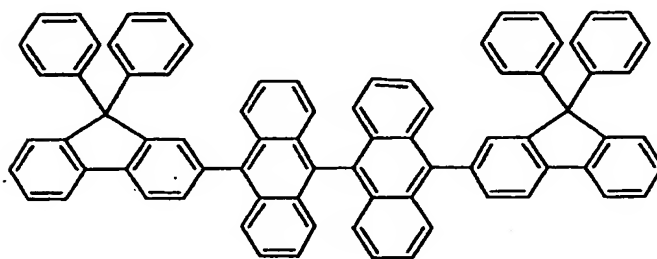
H-22



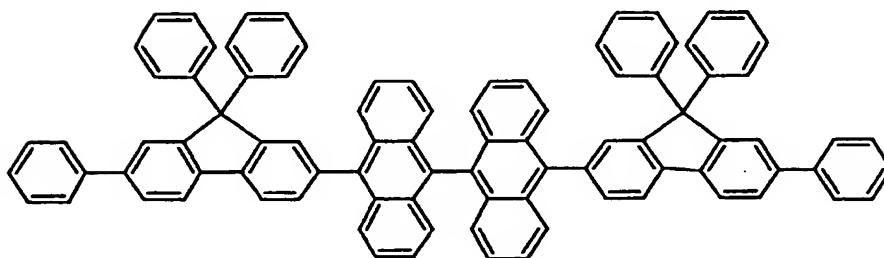
H-23



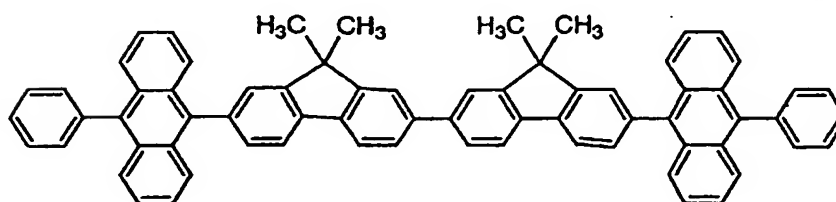
H-24



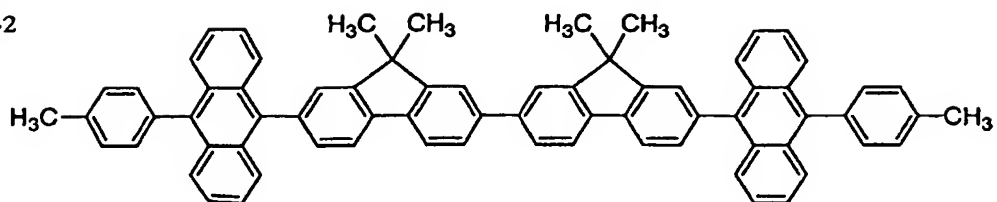
H-25



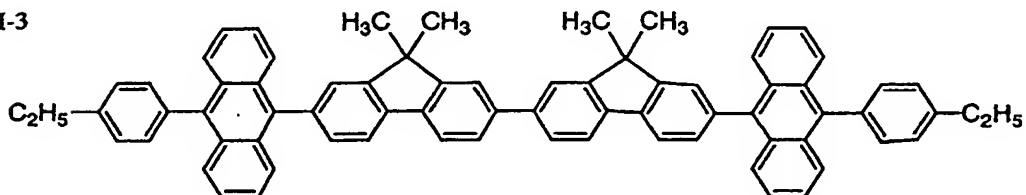
I-1



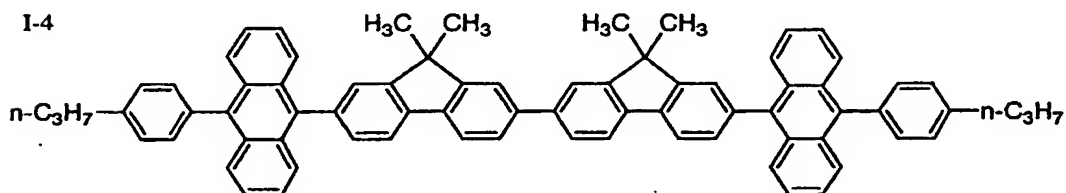
I-2



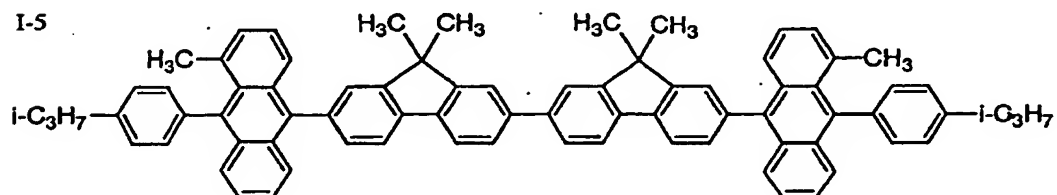
I-3



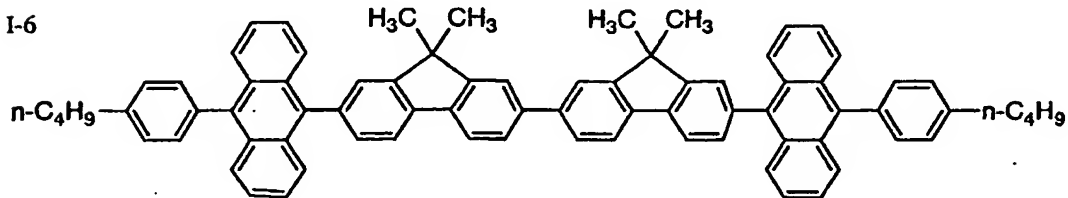
I-4



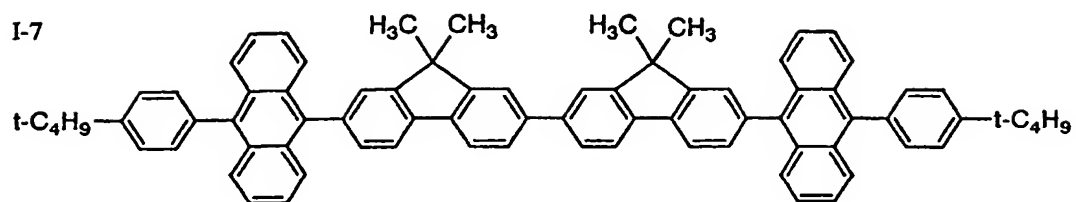
I-5



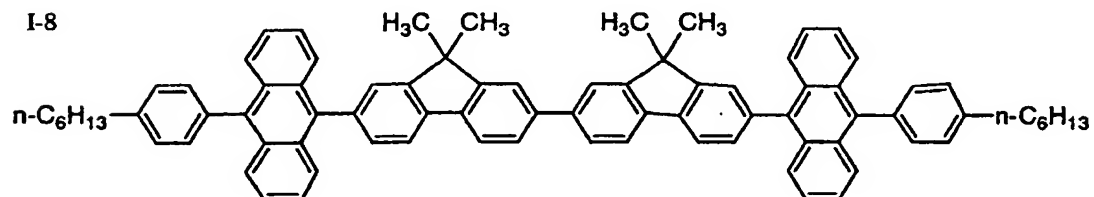
I-6



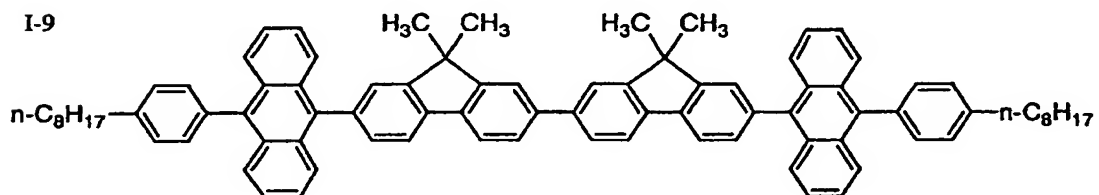
I-7



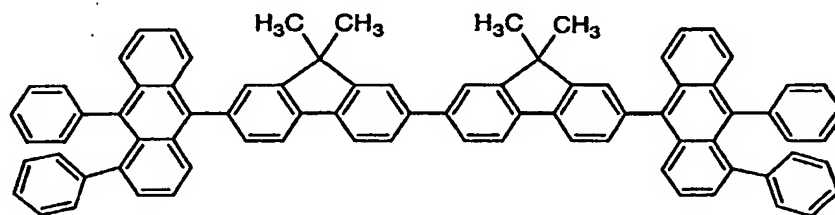
I-8



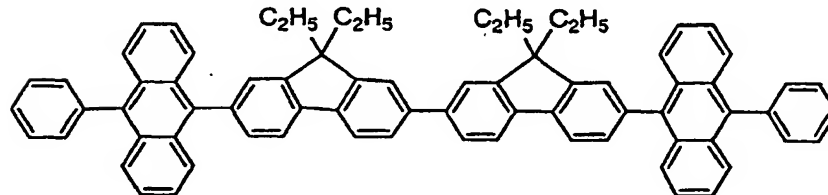
I-9



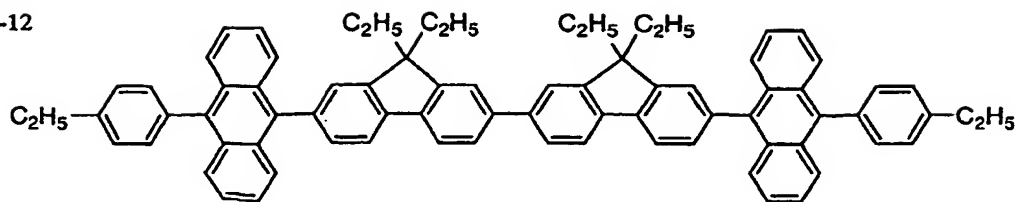
I-10



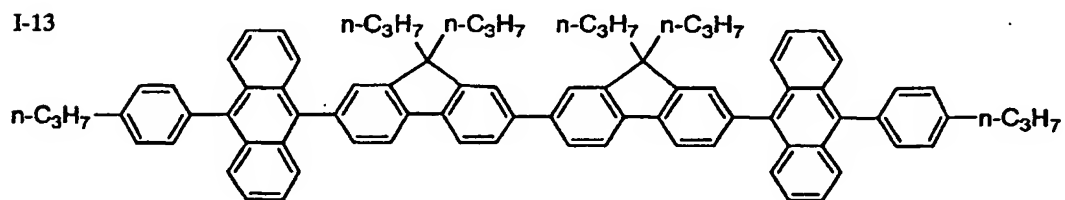
I-11



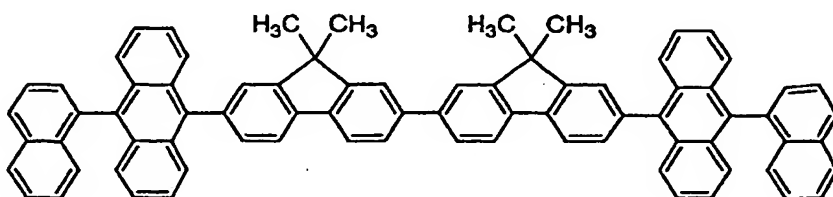
I-12



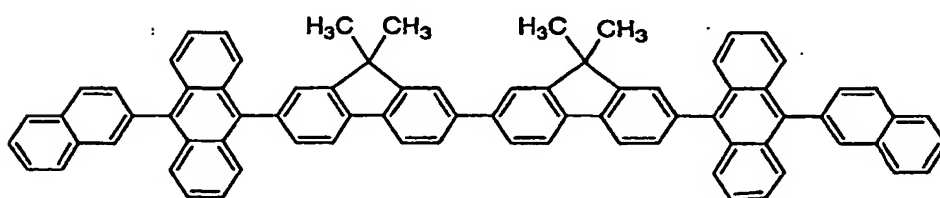
I-13



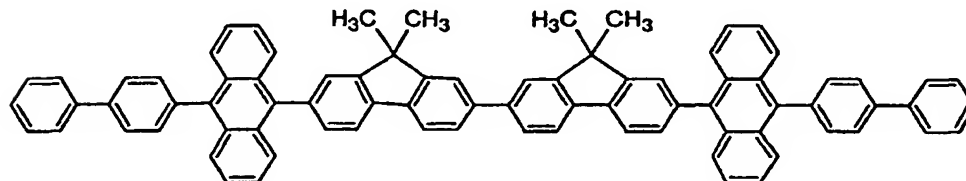
I-14



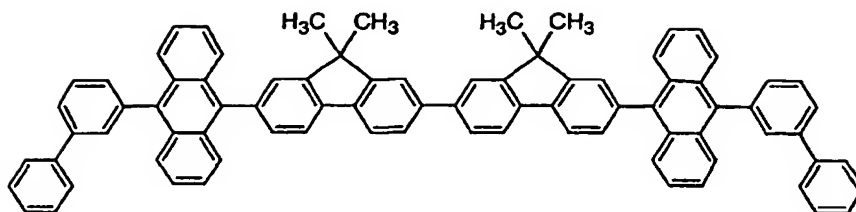
I-15



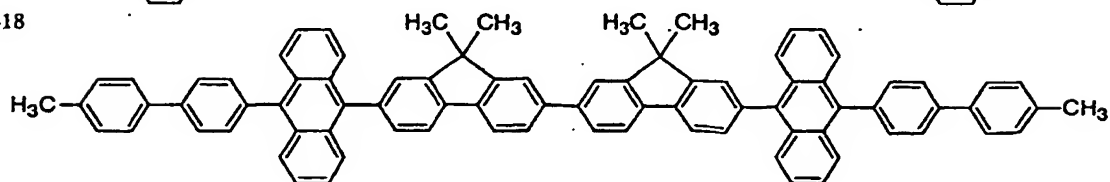
I-16



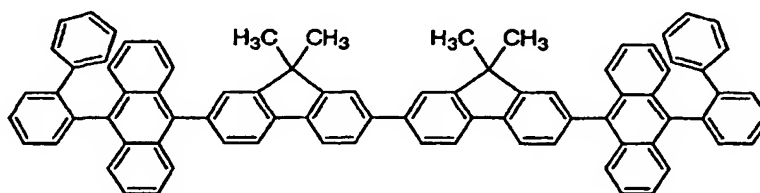
I-17



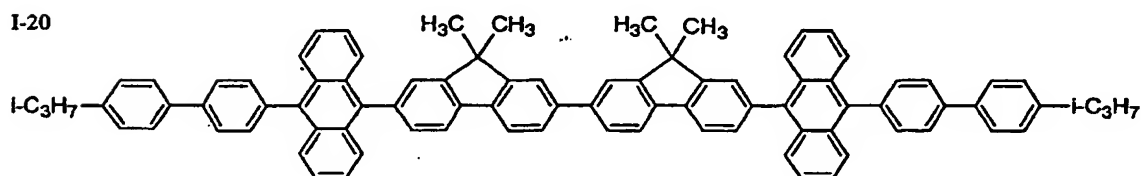
I-18



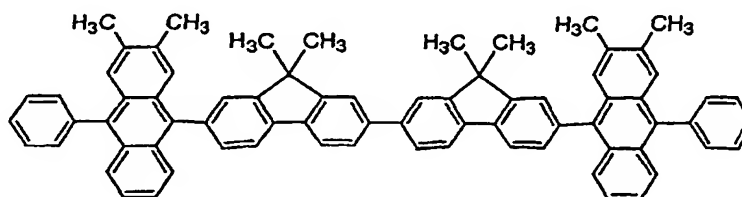
I-19



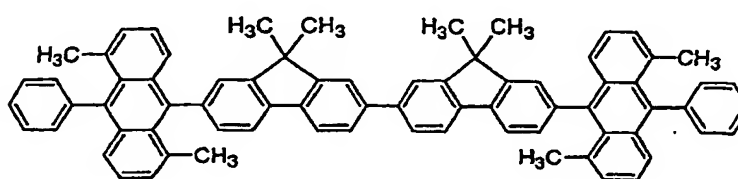
I-20



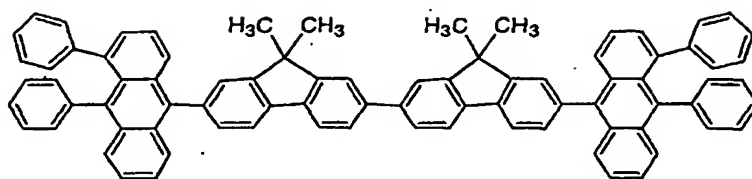
I-21



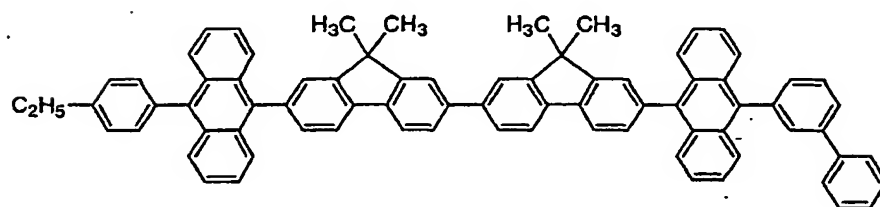
I-22



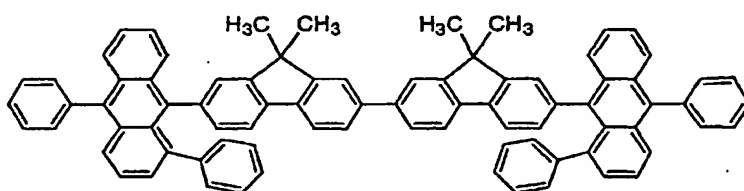
I-23



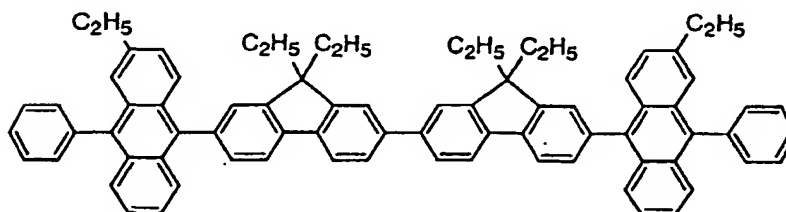
I-24



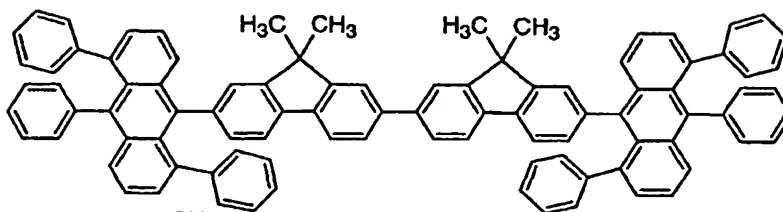
I-25



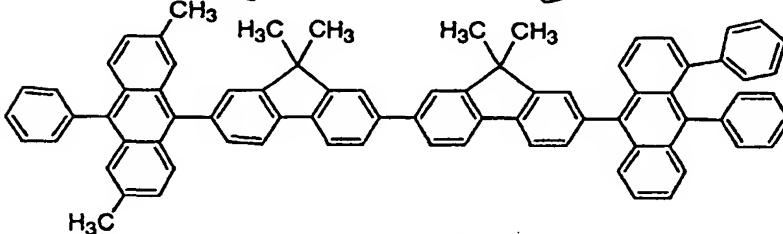
I-26



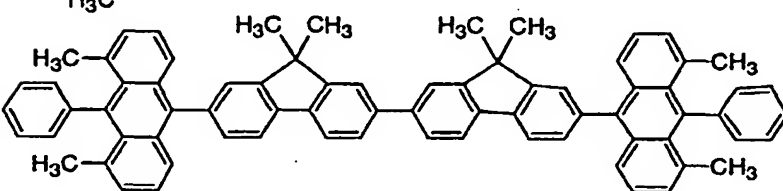
I-27



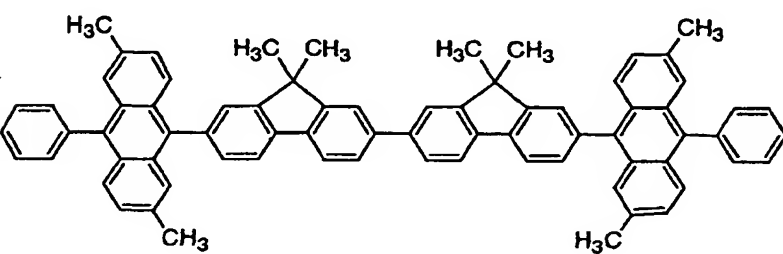
I-27



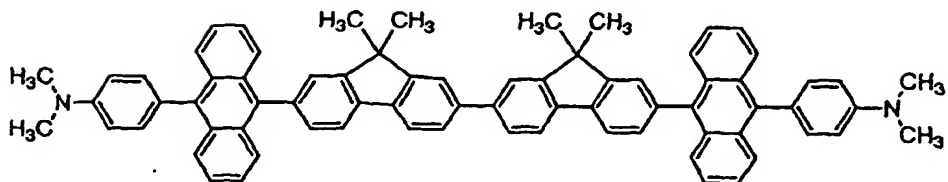
I-29



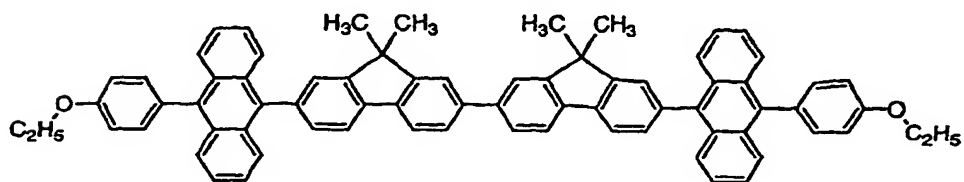
I-30



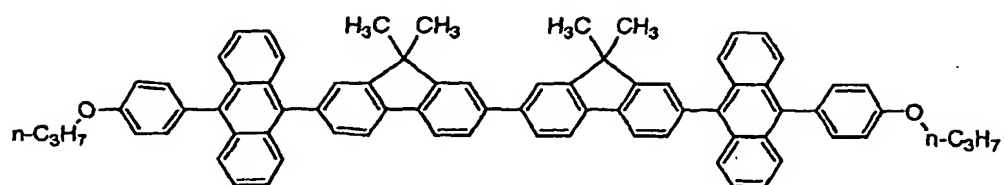
I-31



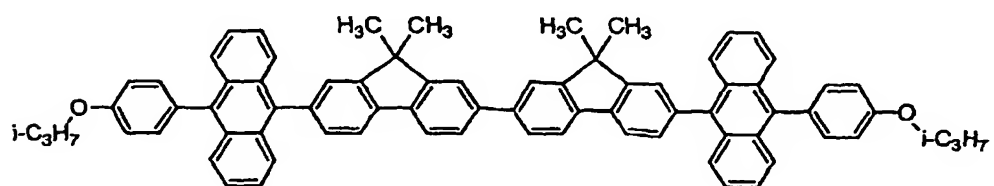
I-32



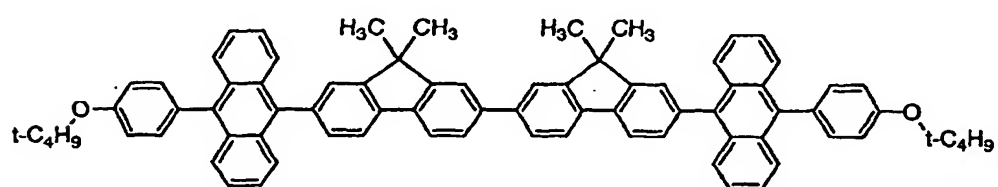
I-33



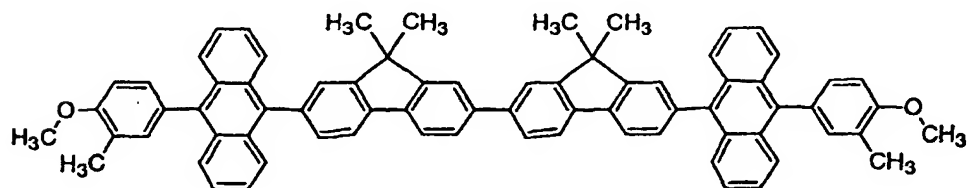
I-34



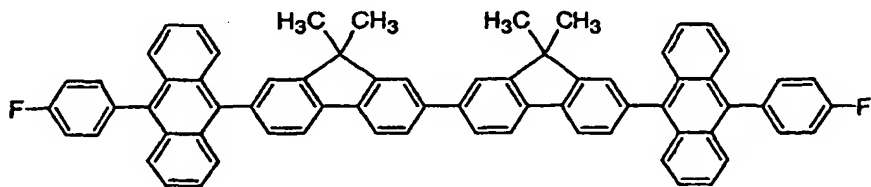
I-35



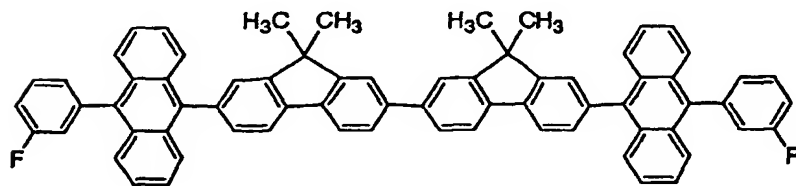
I-36



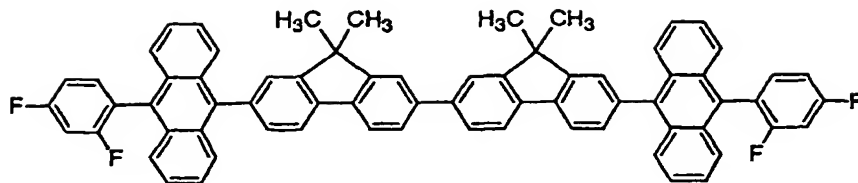
I-37



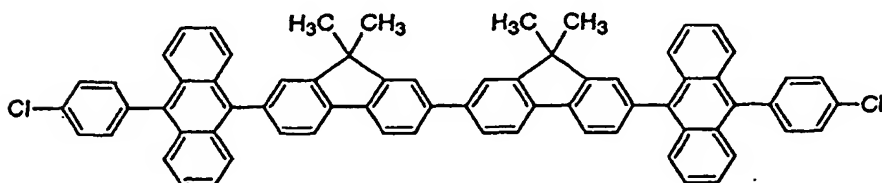
I-38



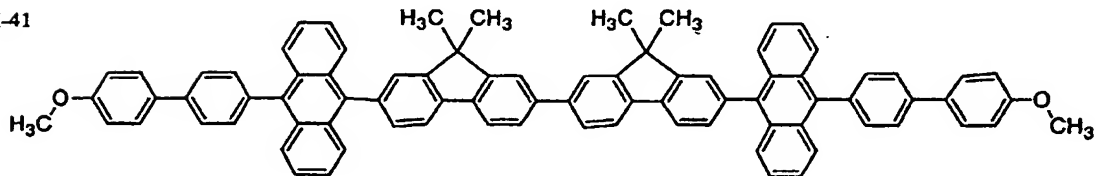
I-39



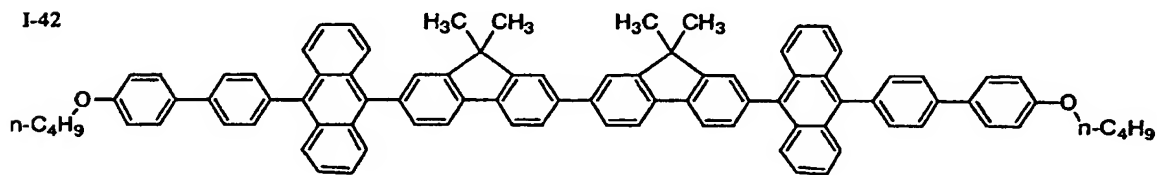
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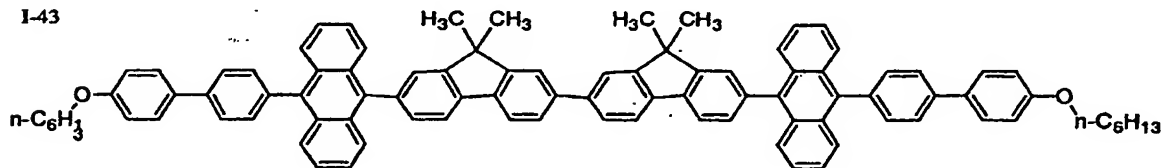
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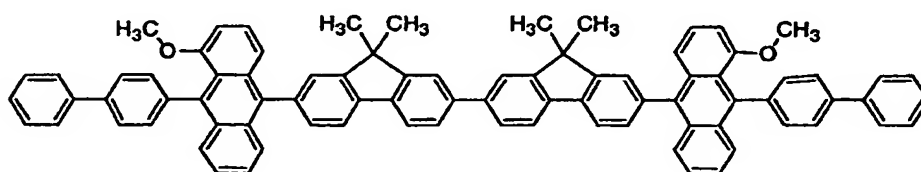
I-42



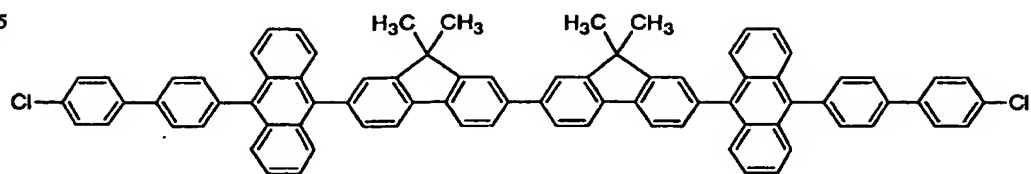
I-43



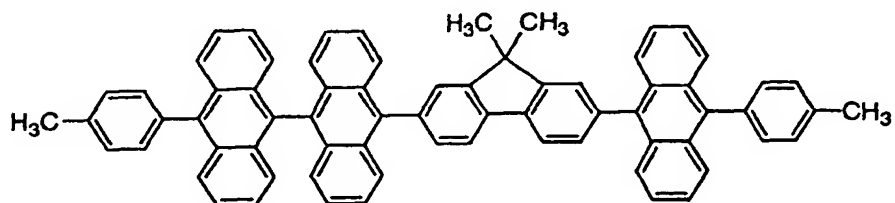
I-44



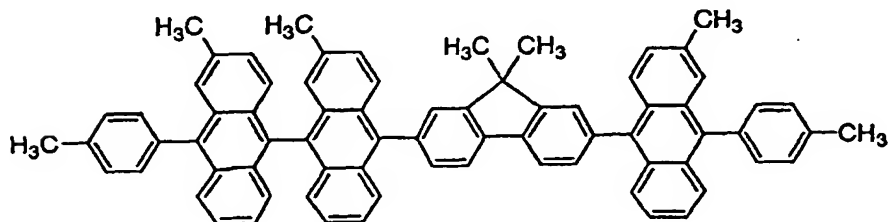
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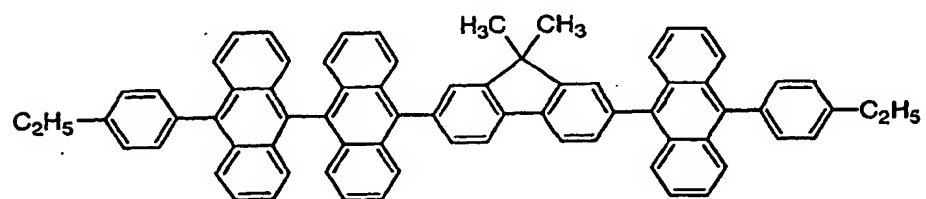
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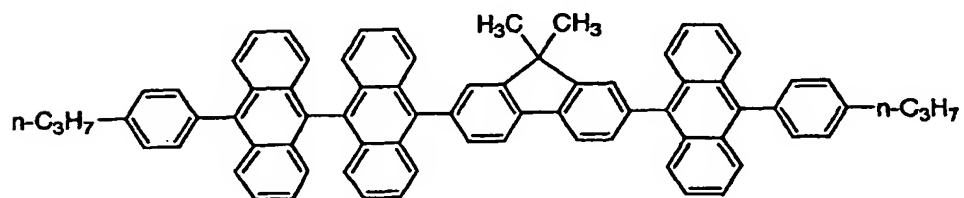
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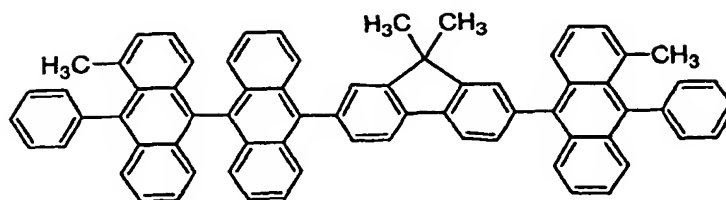
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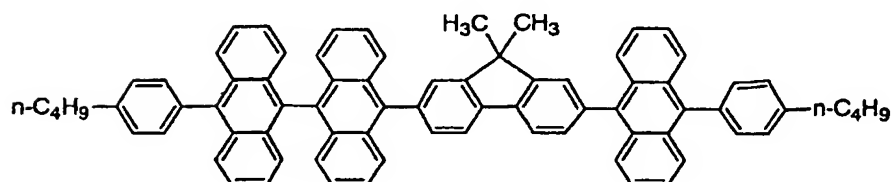
J-4



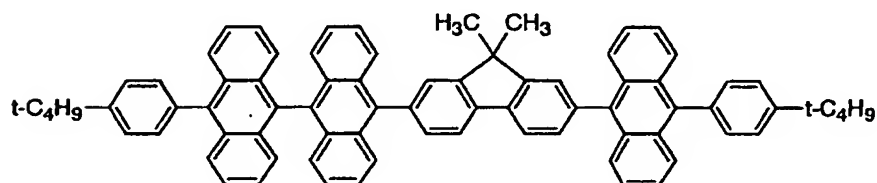
J-5



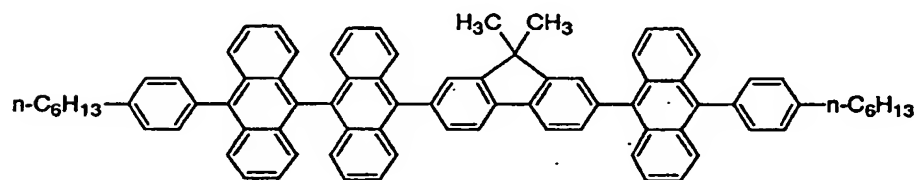
J-6



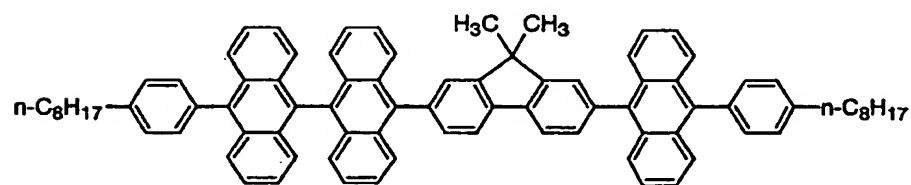
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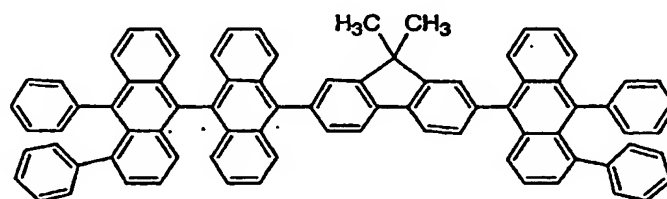
J-8



J-9



J-10



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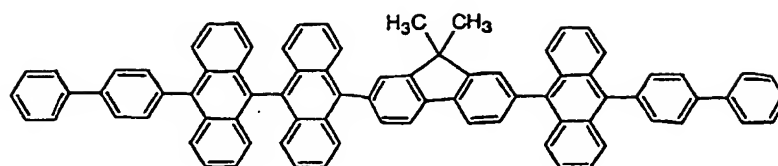
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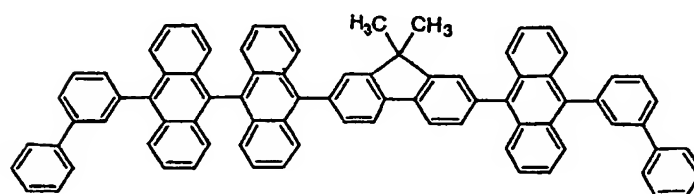
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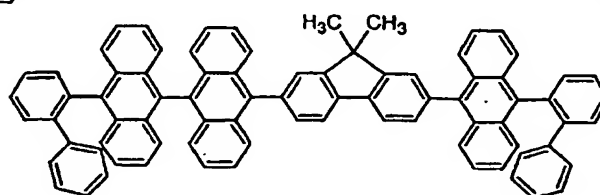
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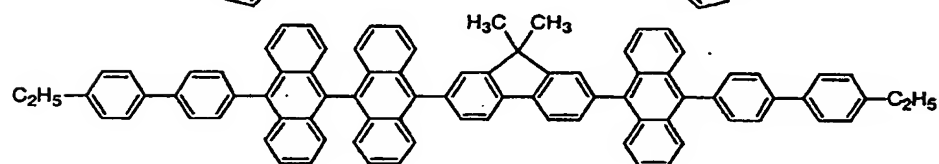
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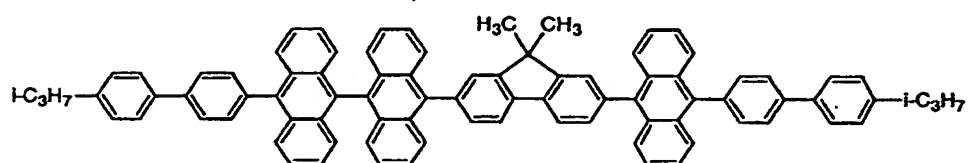
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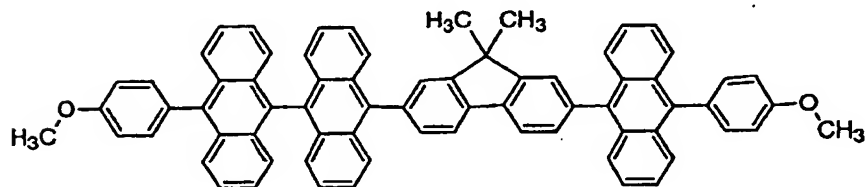
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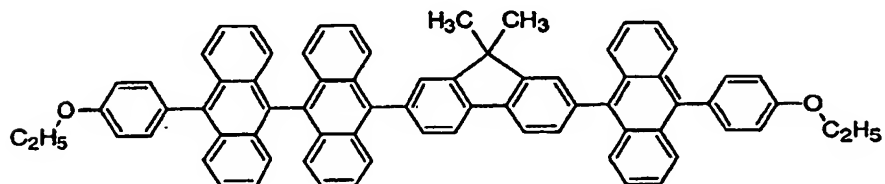
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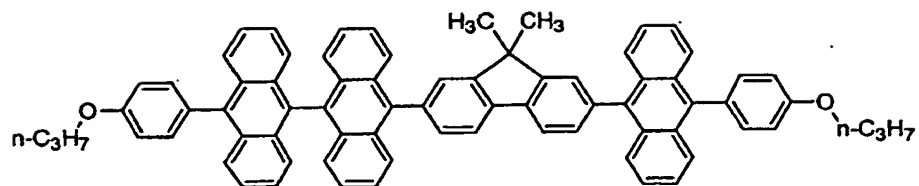
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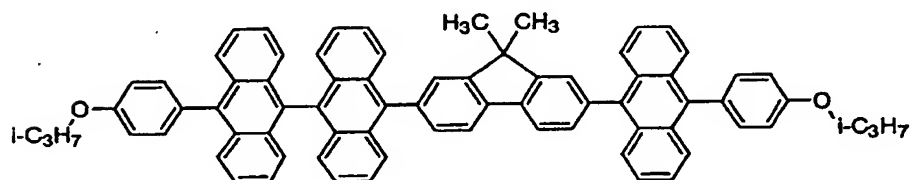
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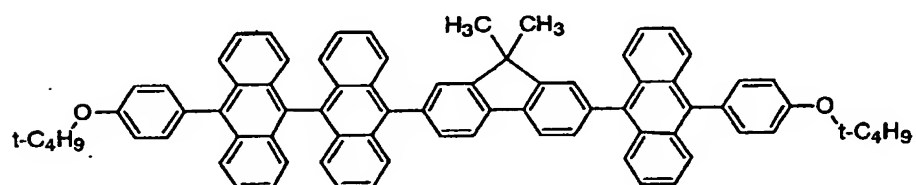
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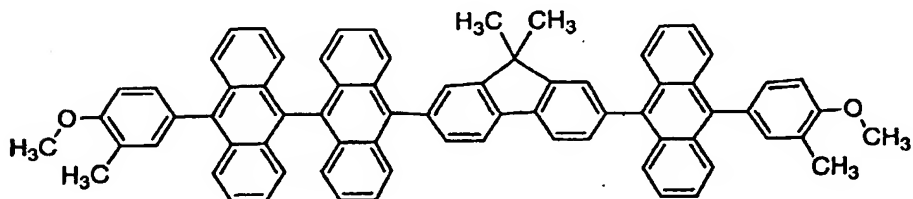
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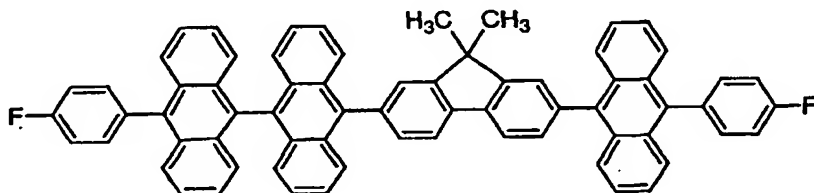
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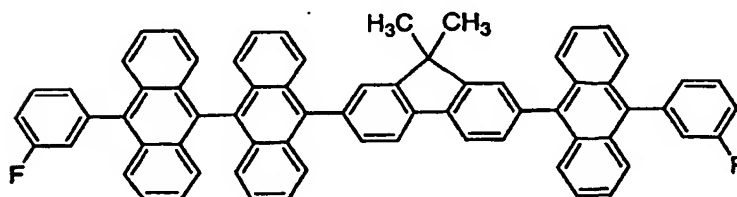
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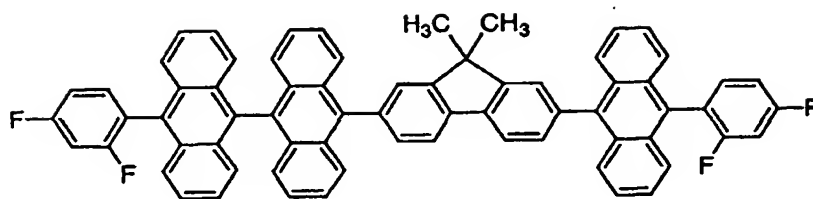
J-27



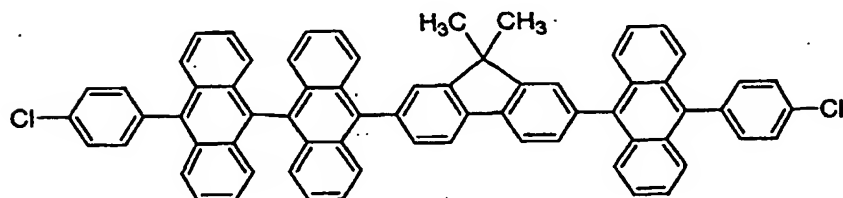
J-28



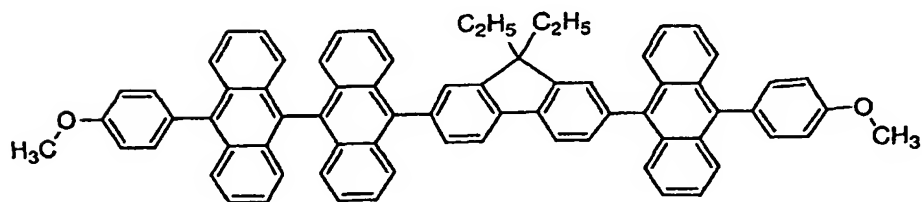
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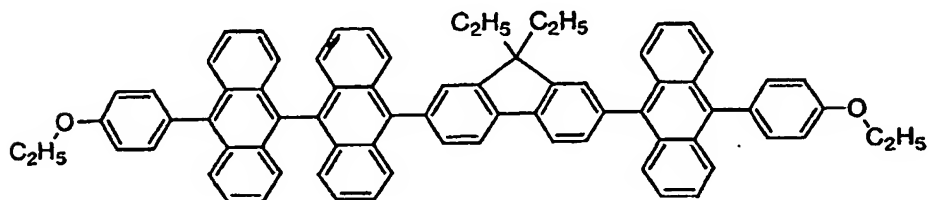
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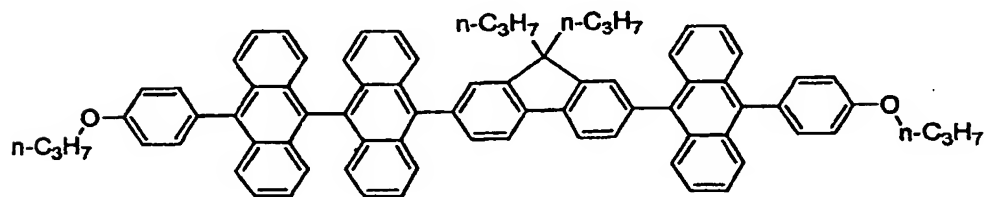
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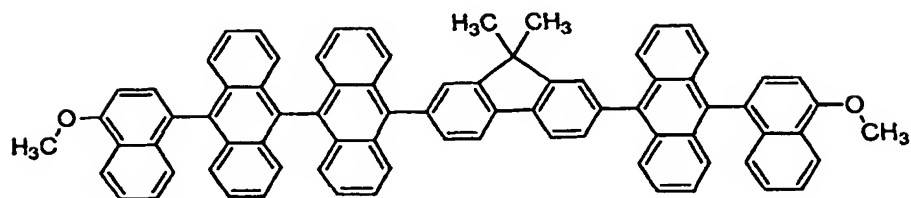
J-32



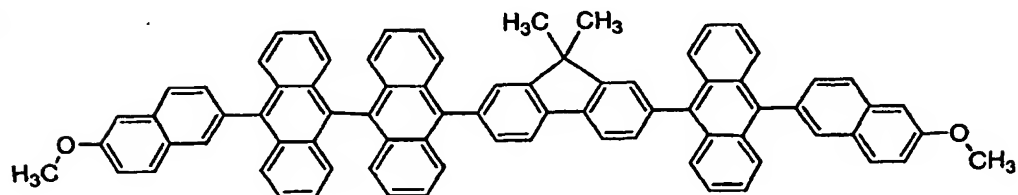
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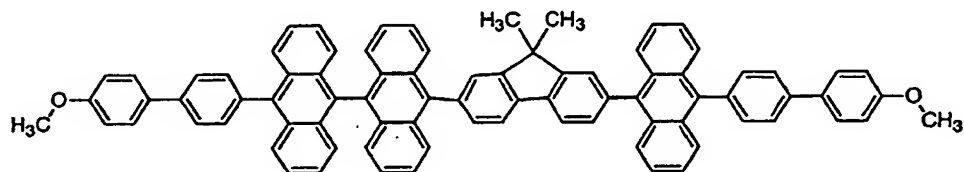
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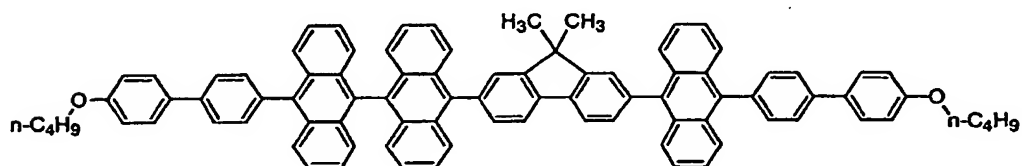
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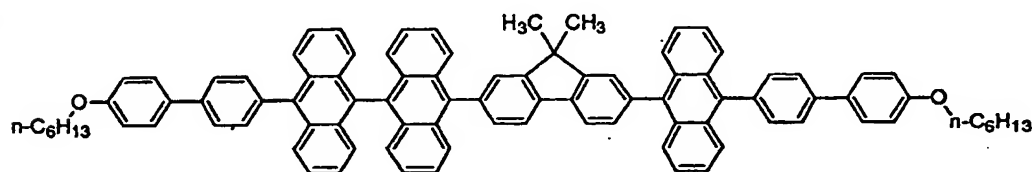
J-36



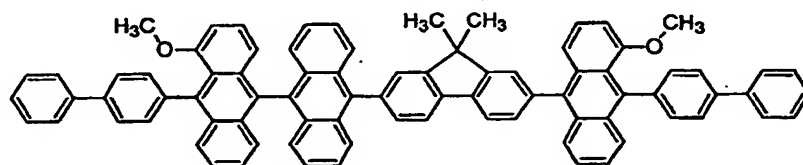
J-37



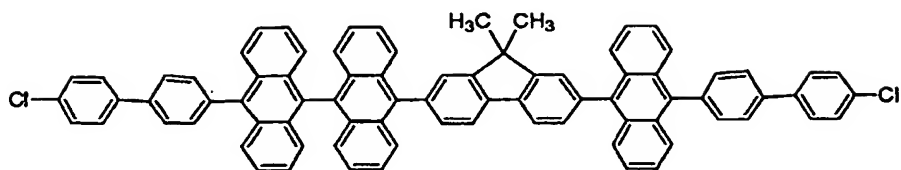
J-38



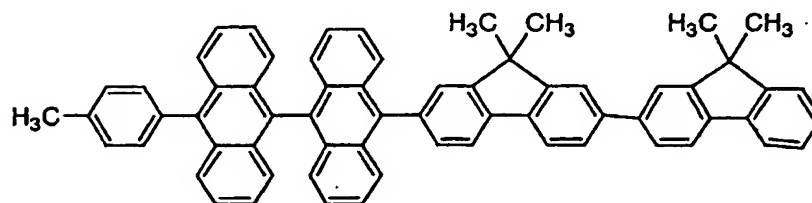
J-39



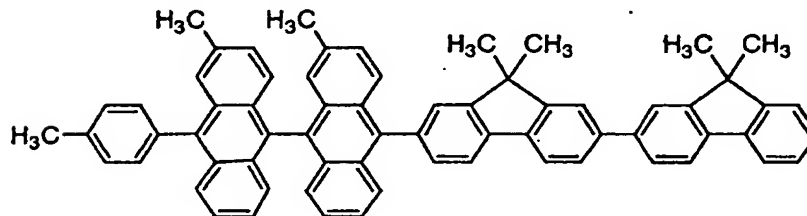
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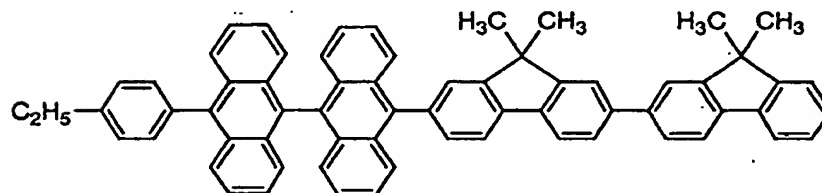
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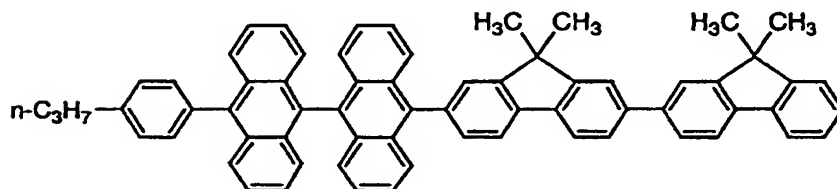
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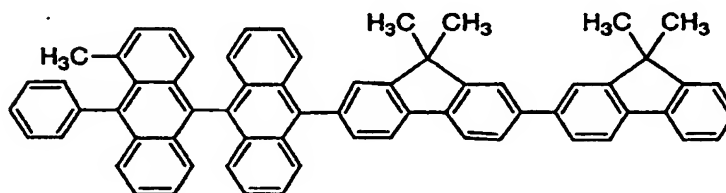
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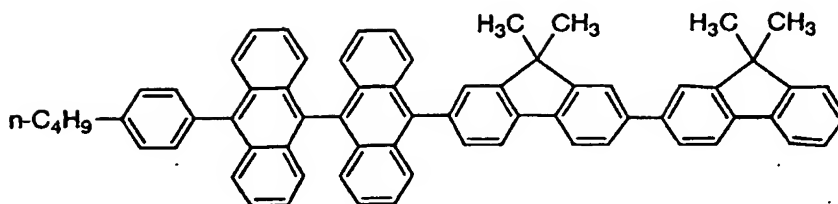
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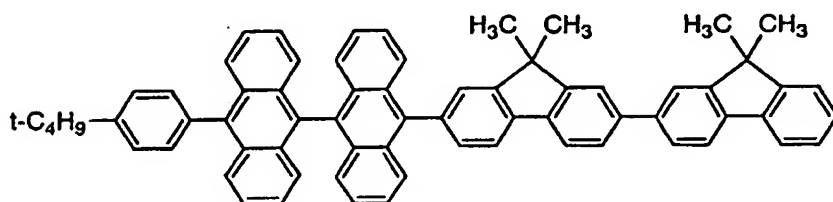
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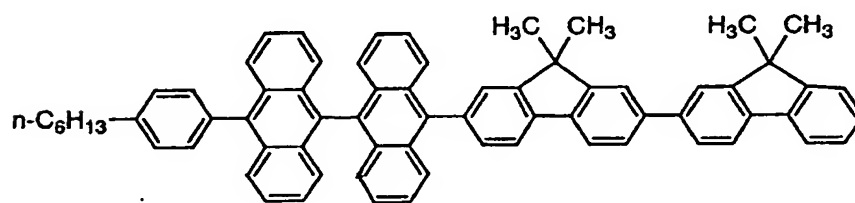
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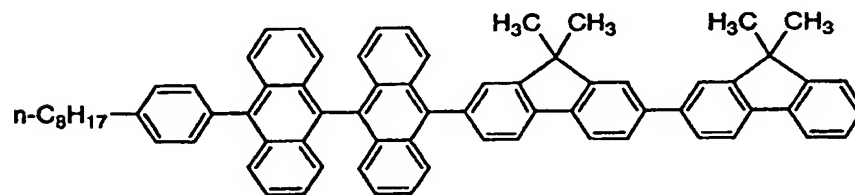
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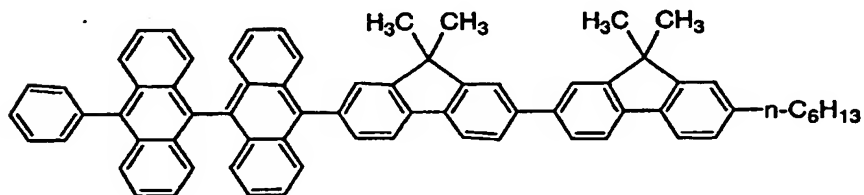
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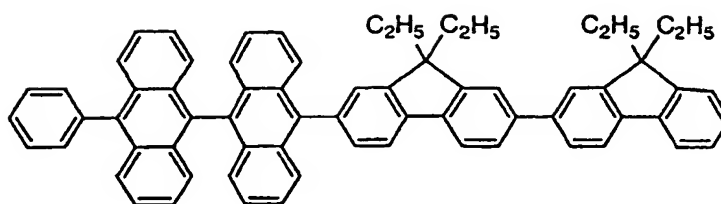
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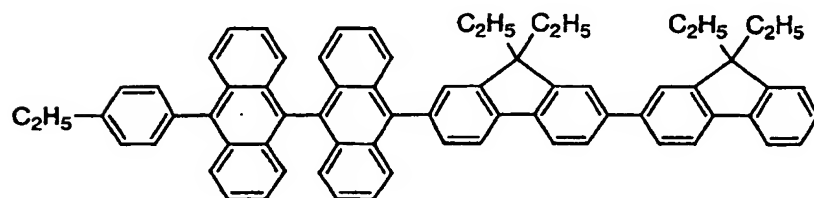
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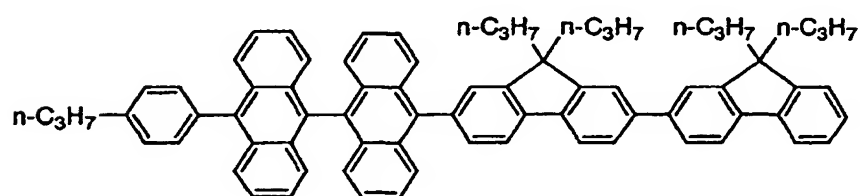
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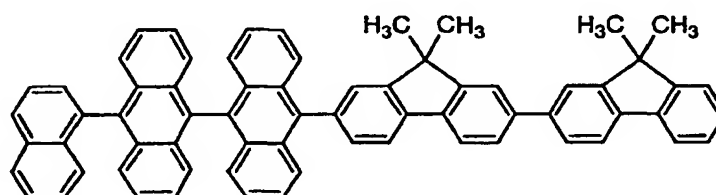
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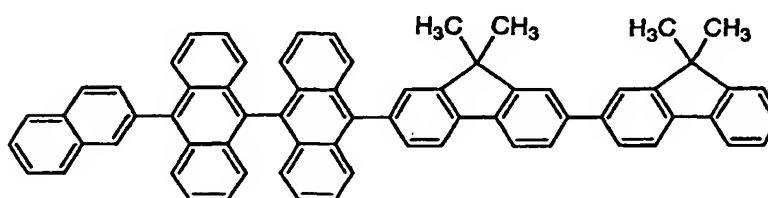
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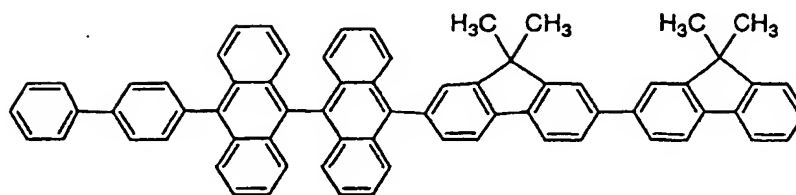
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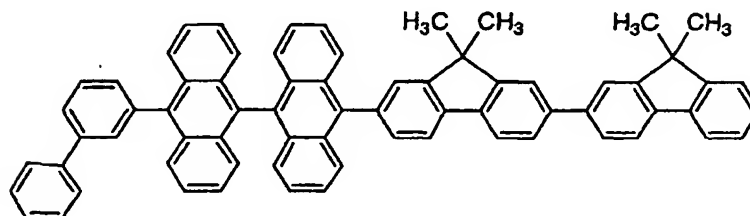
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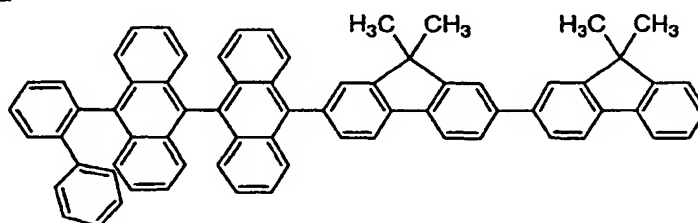
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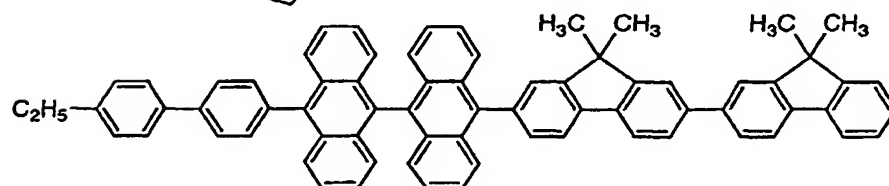
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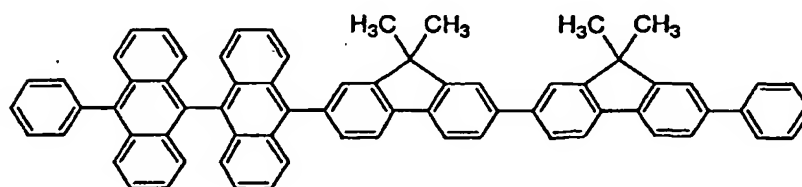
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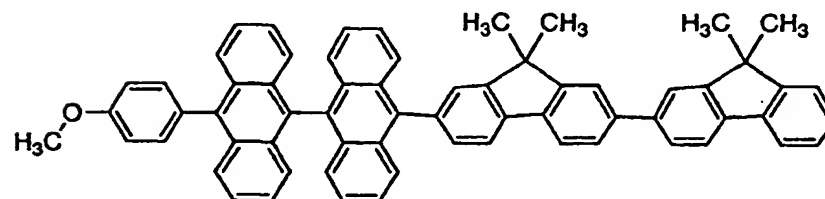
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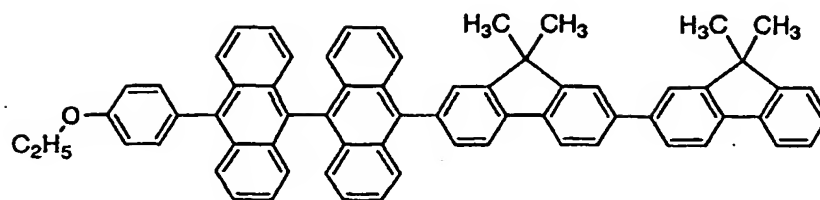
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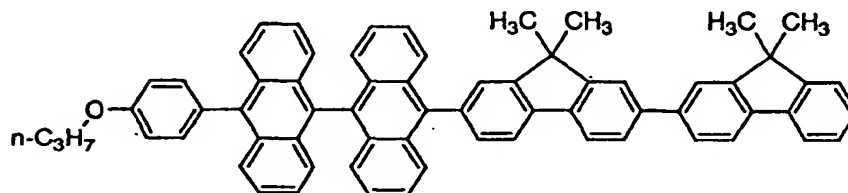
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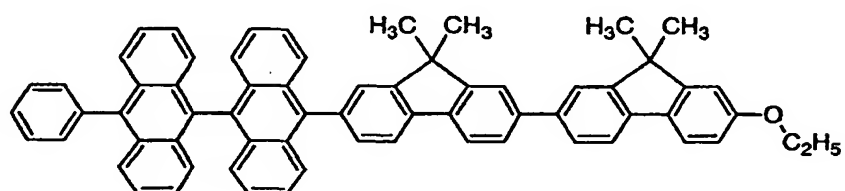
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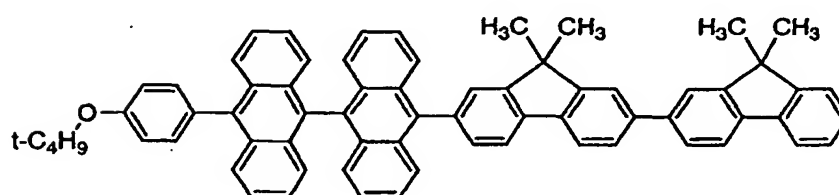
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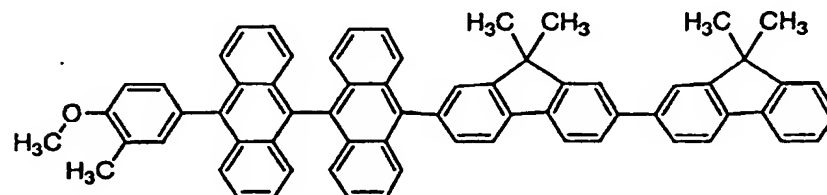
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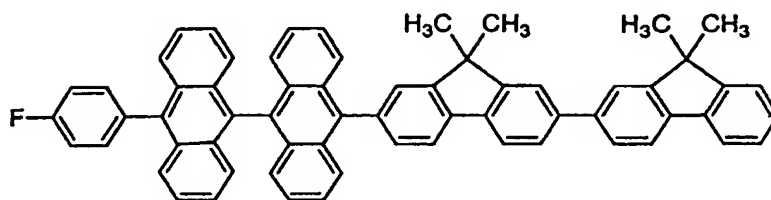
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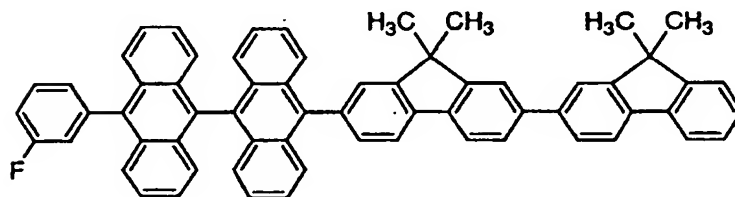
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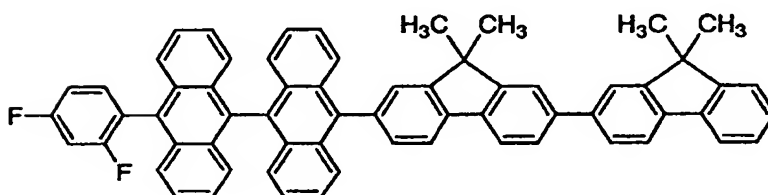
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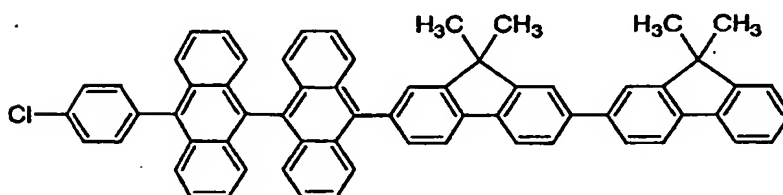
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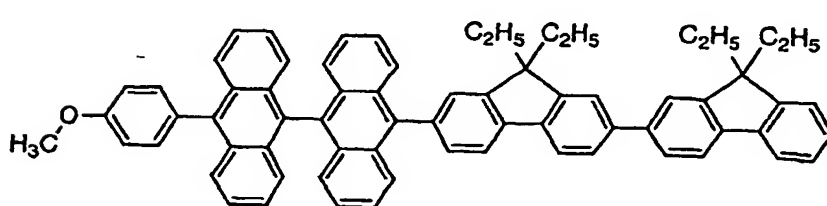
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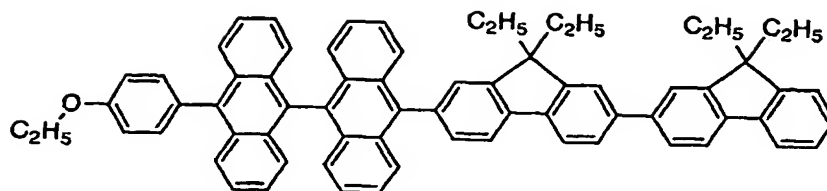
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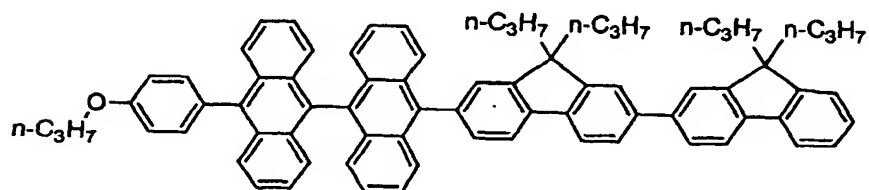
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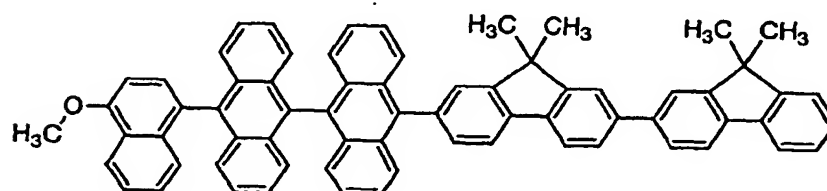
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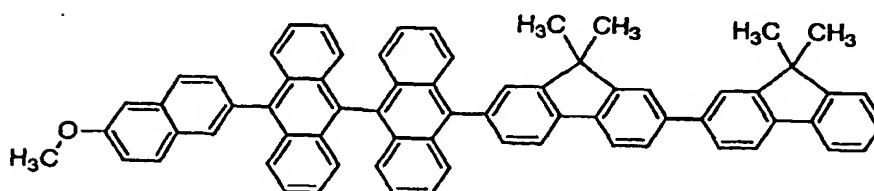
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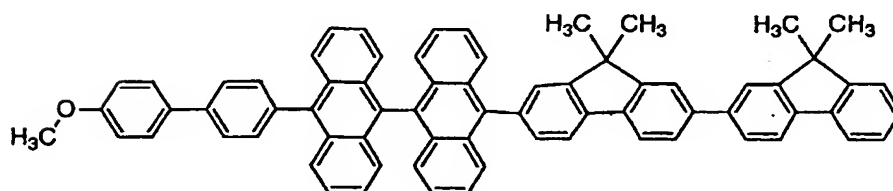
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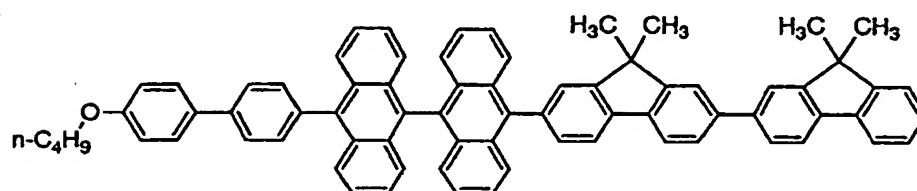
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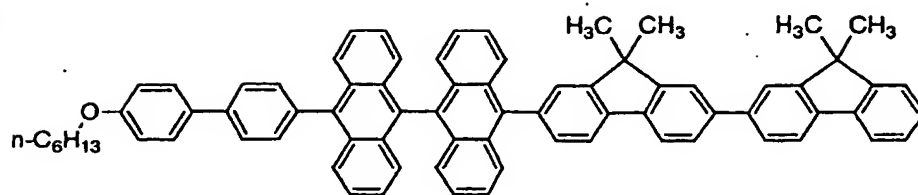
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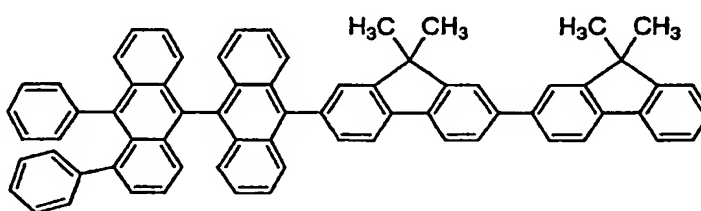
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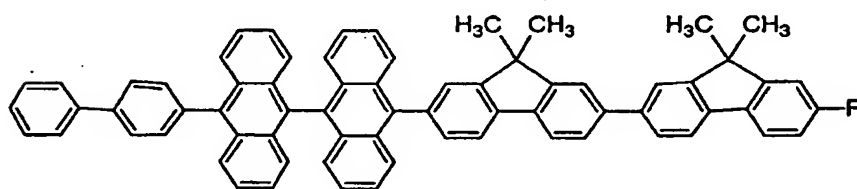
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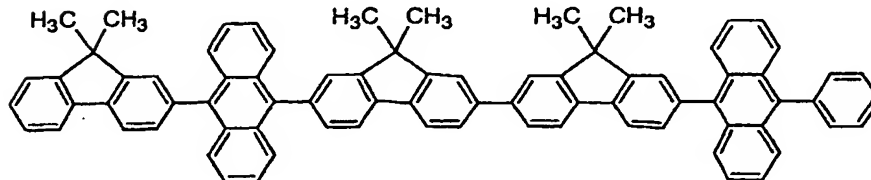
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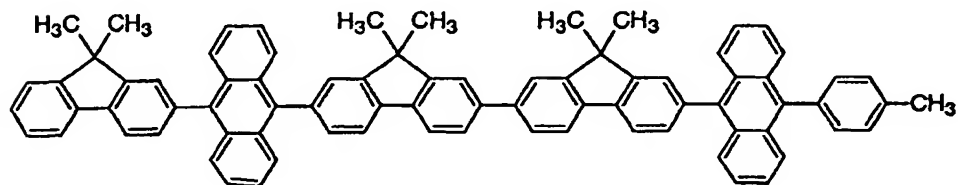
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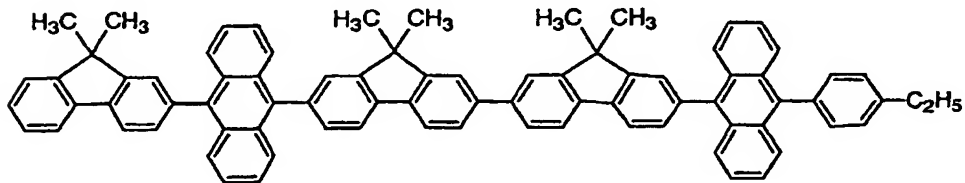
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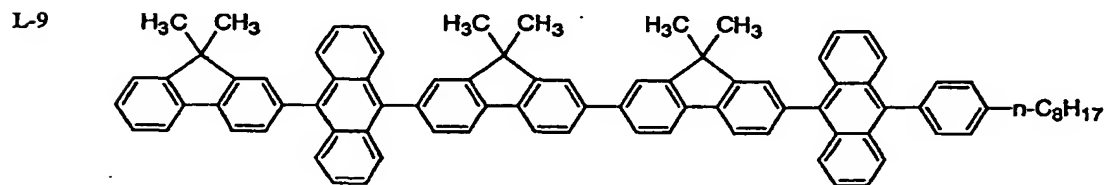
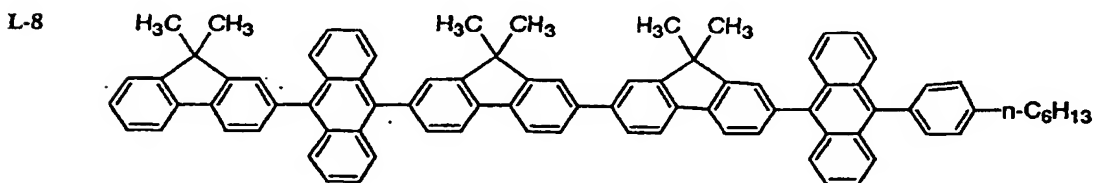
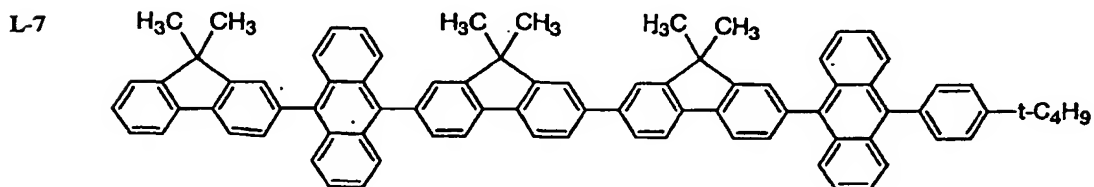
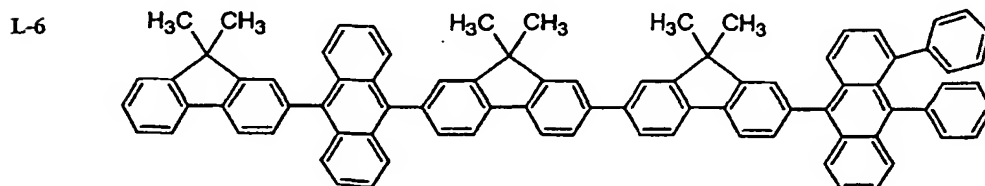
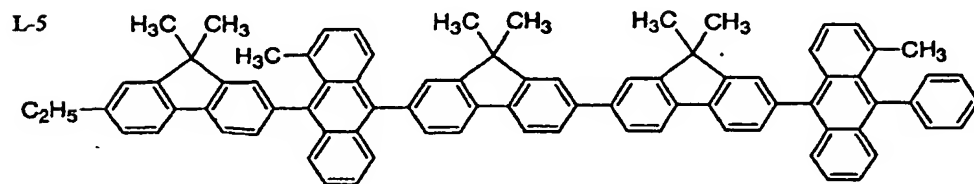
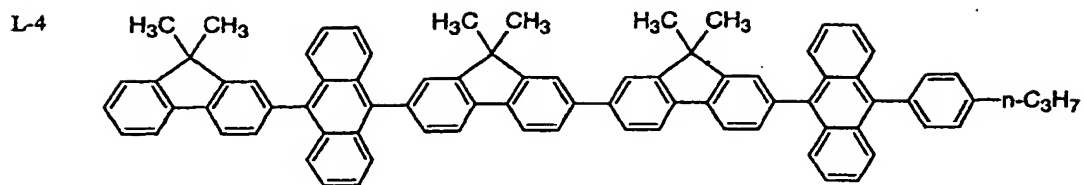


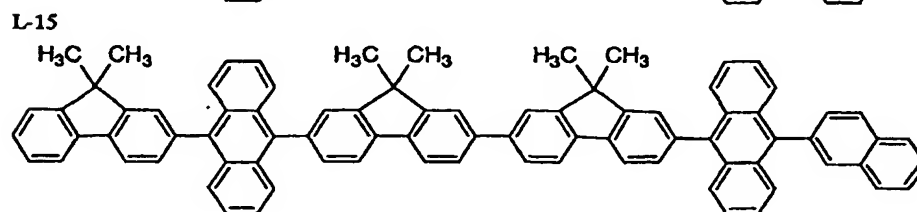
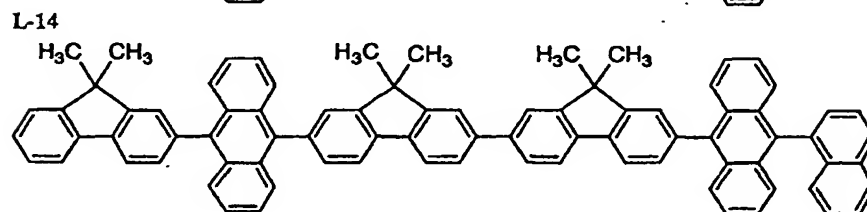
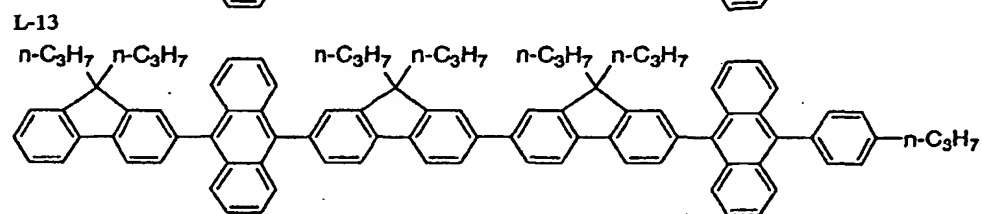
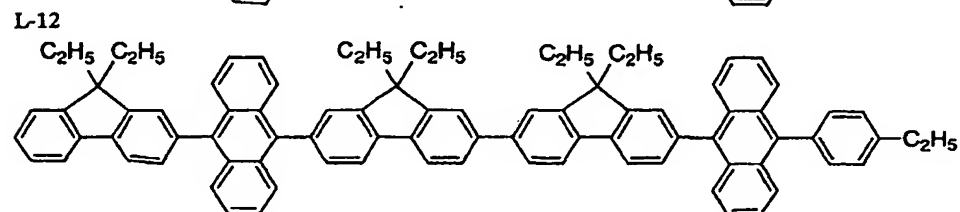
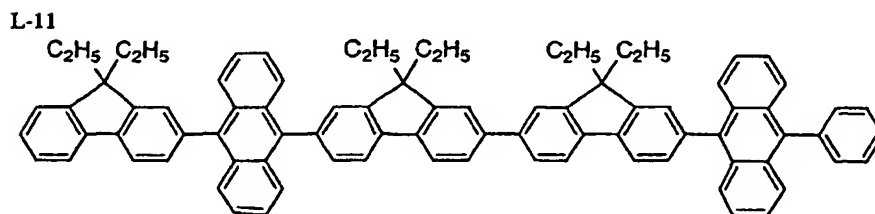
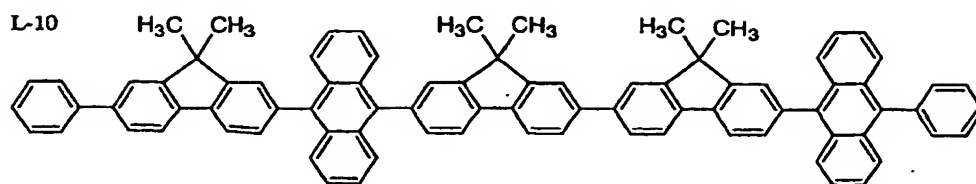
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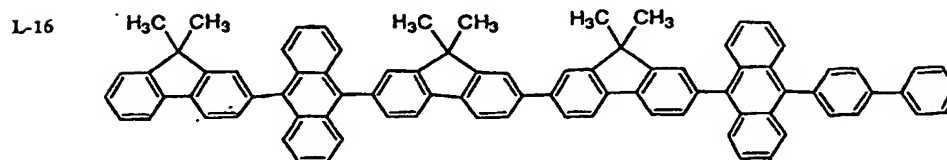
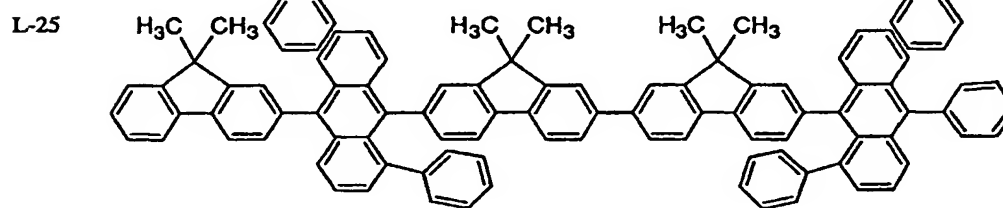
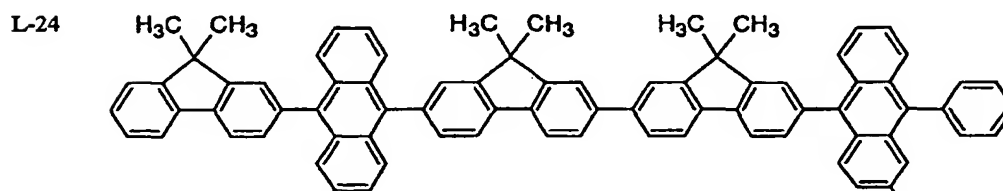
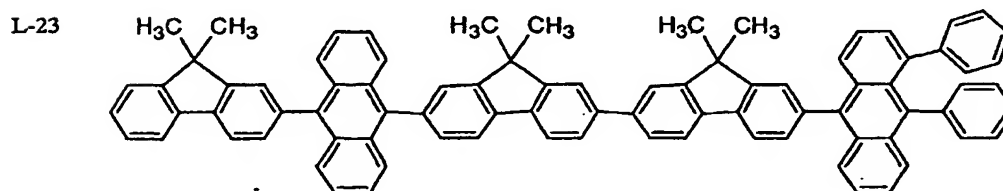
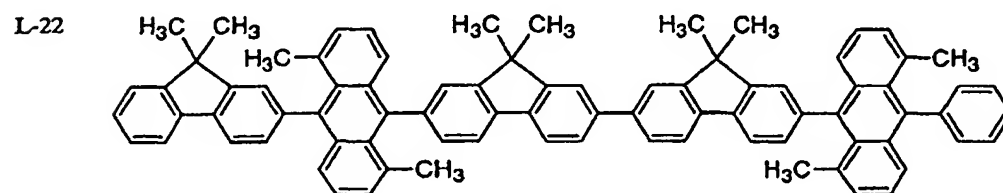
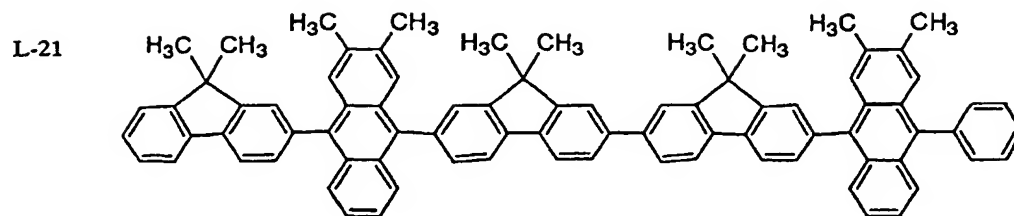


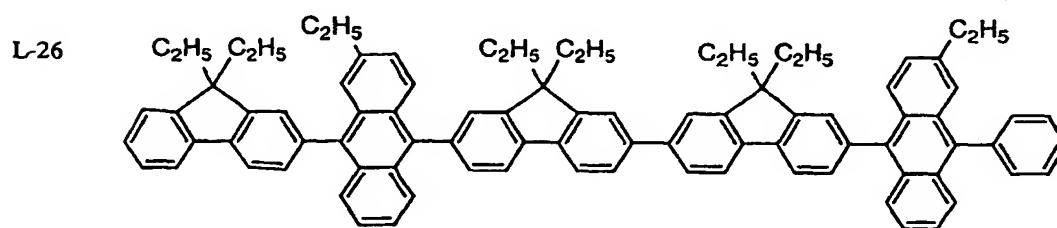
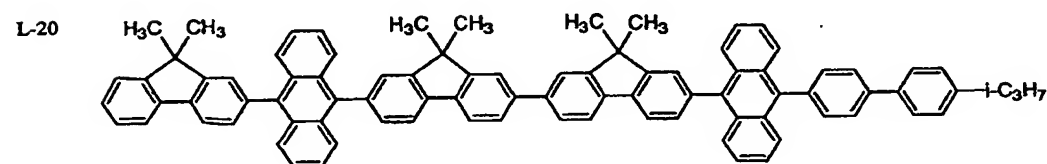
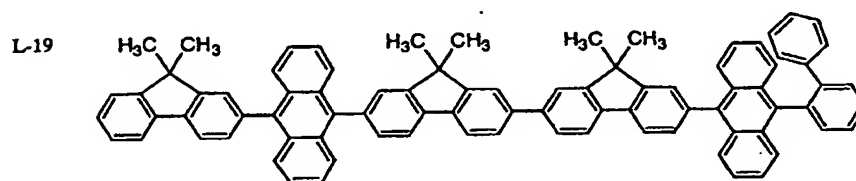
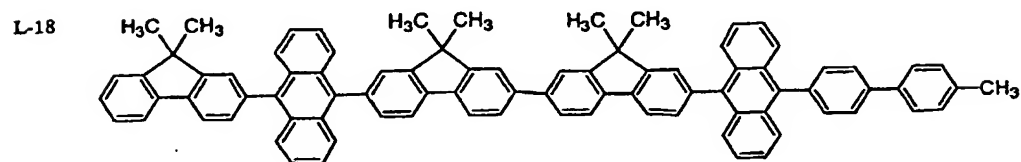
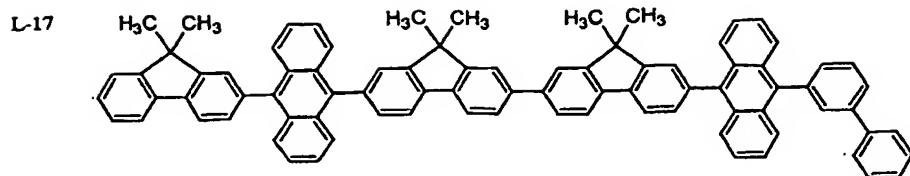
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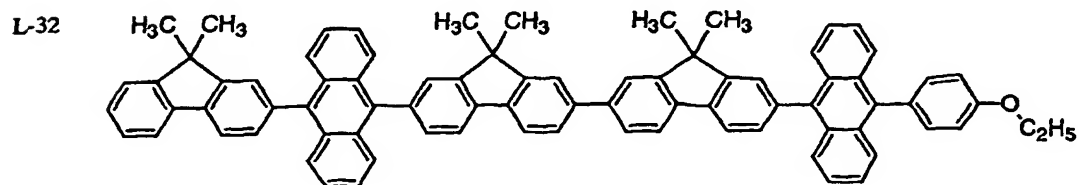
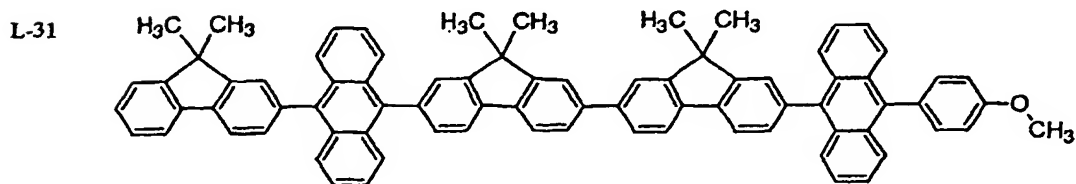
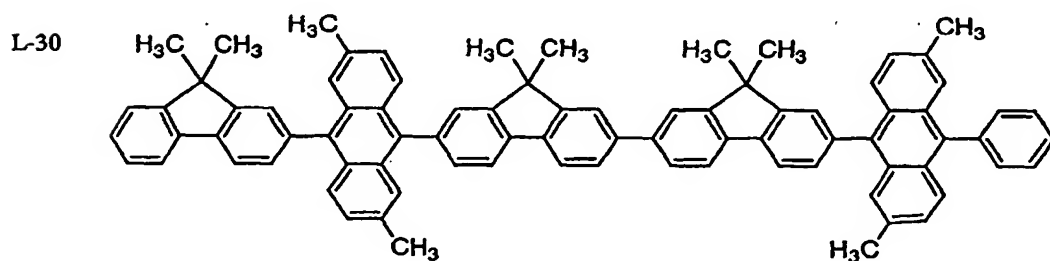
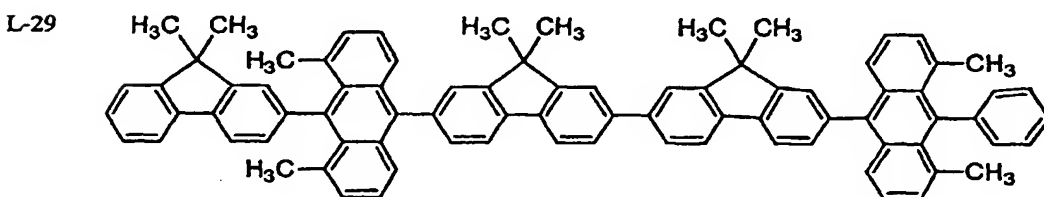
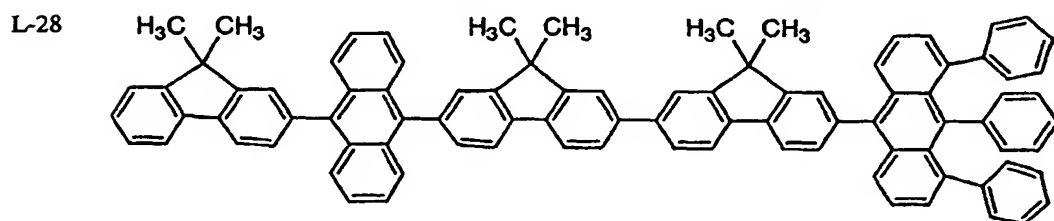
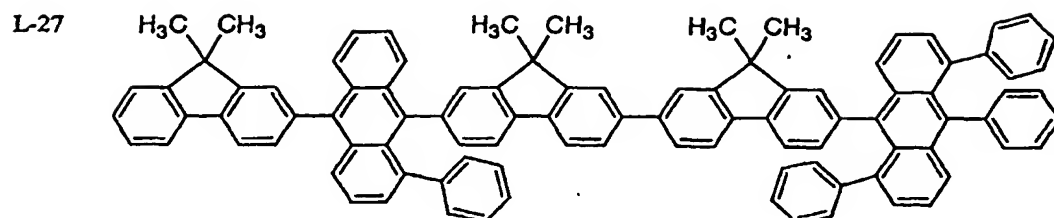


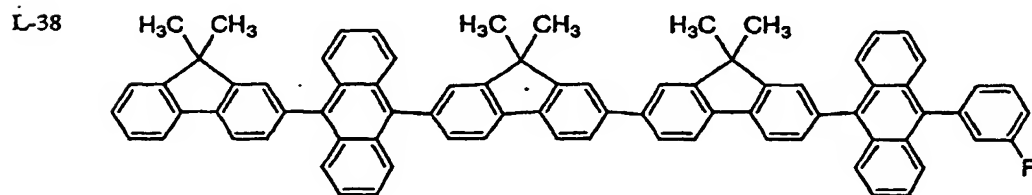
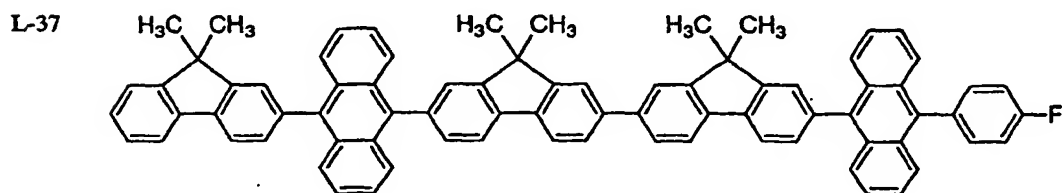
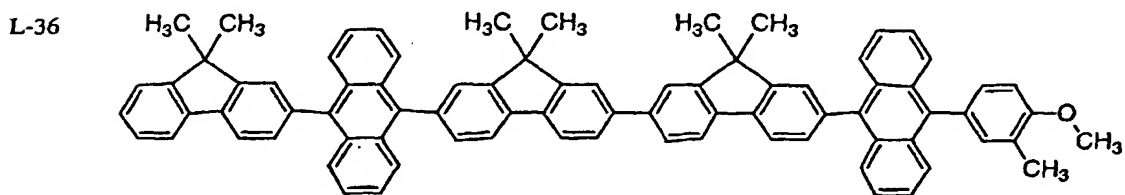
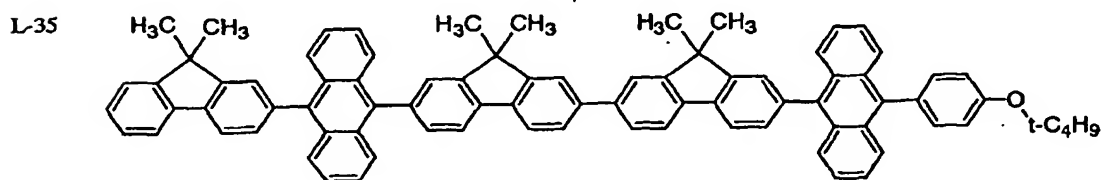
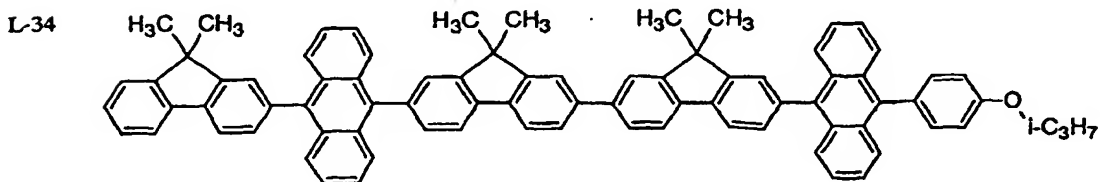
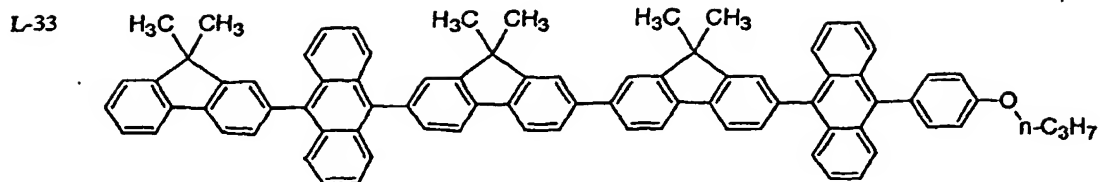




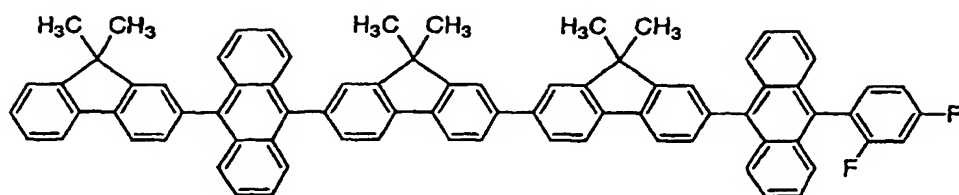




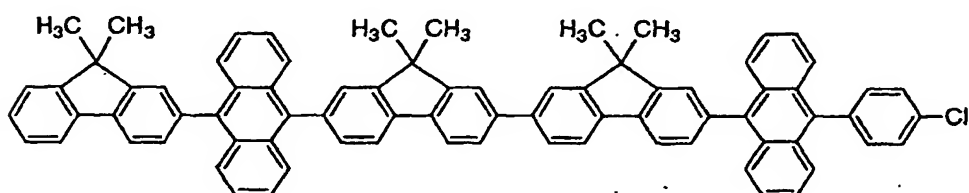




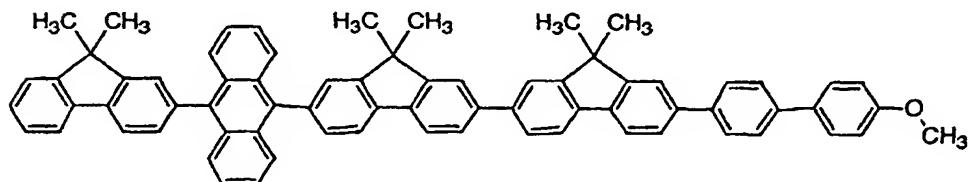
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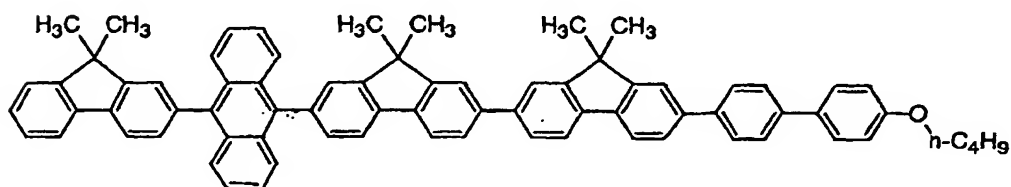
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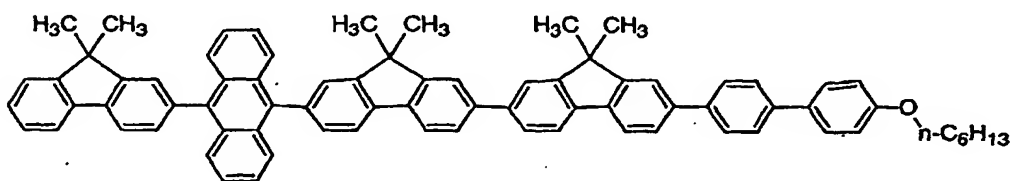
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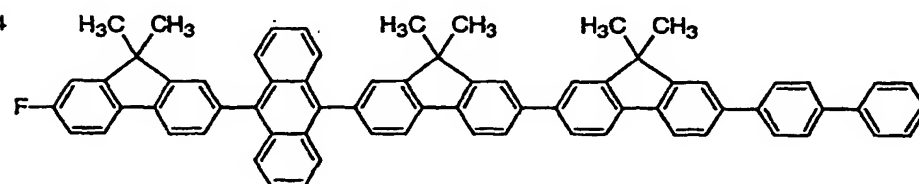
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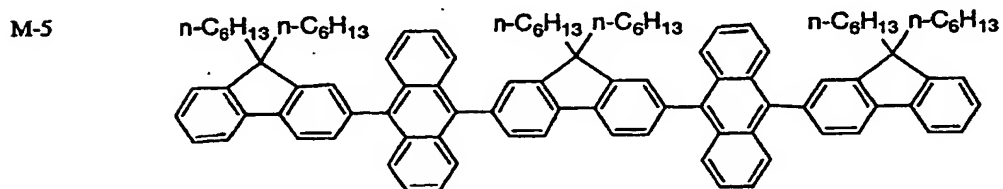
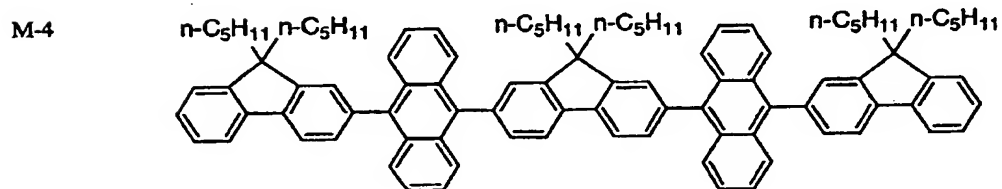
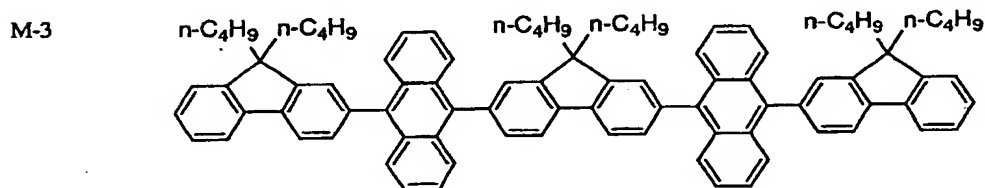
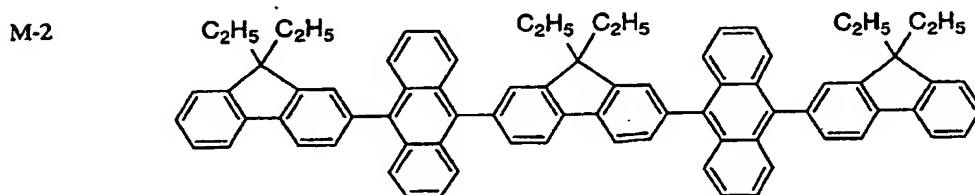
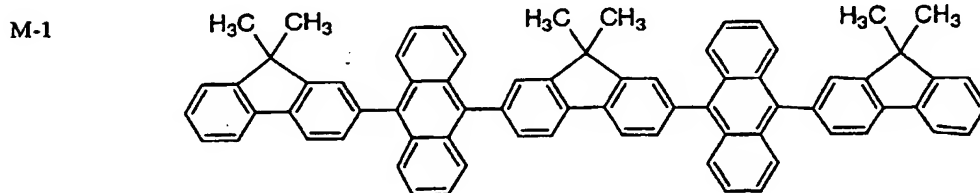
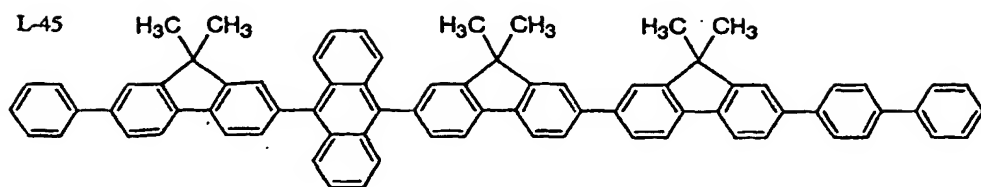


L-43

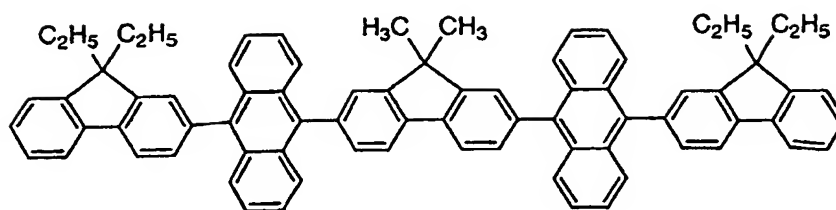


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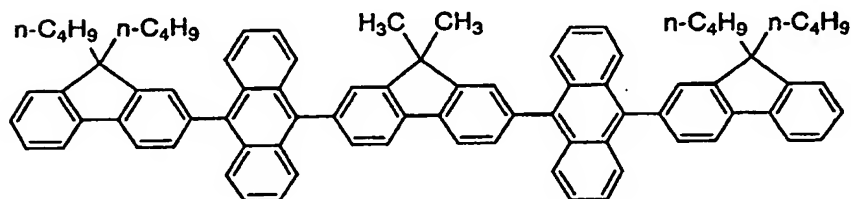




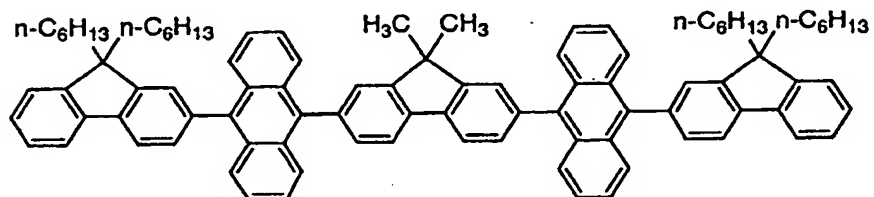
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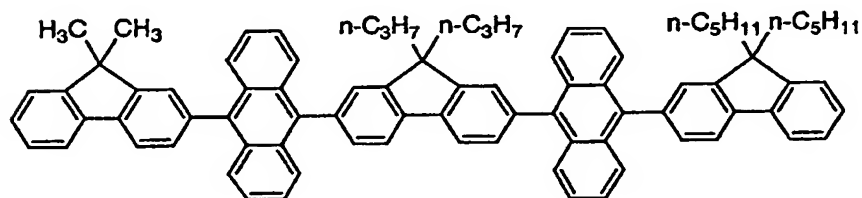
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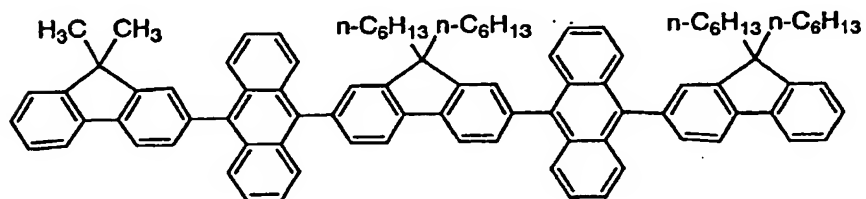
M-8



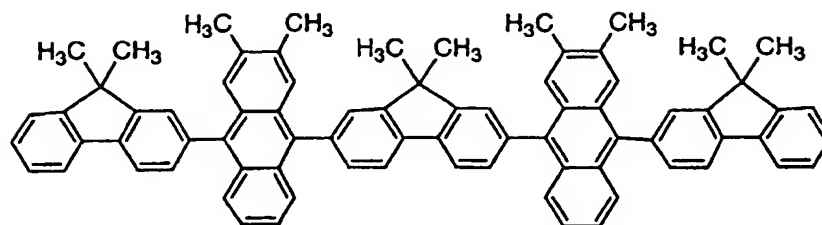
M-9



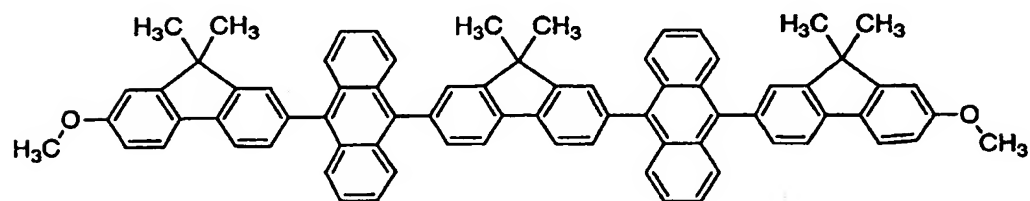
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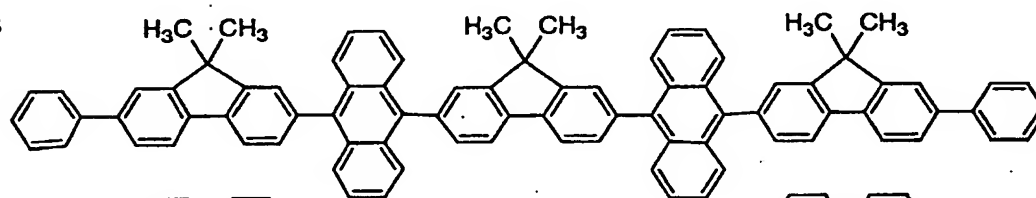
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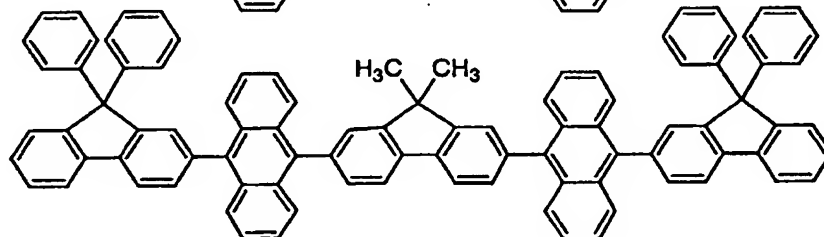
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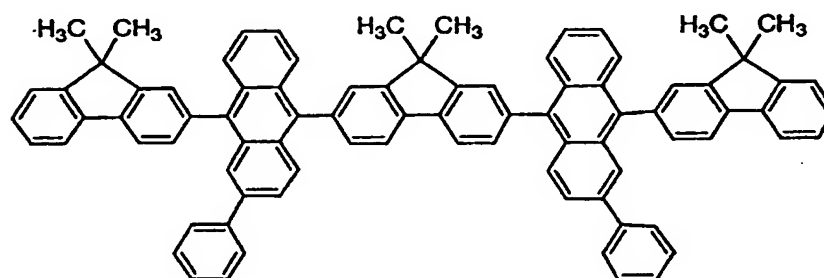
M-13



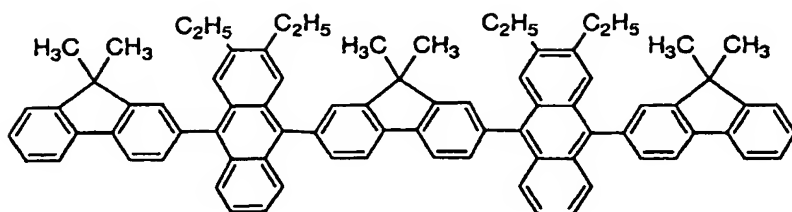
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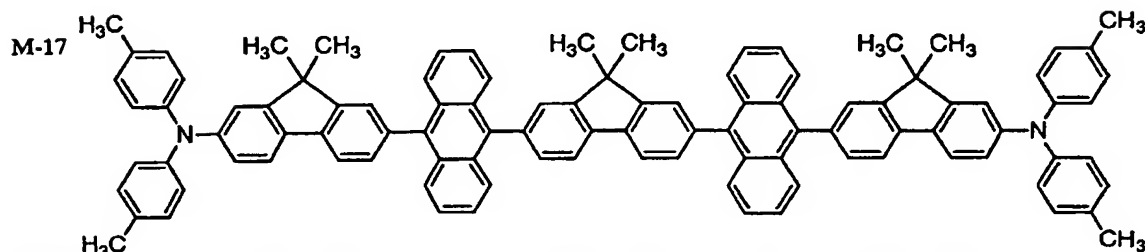
M-15



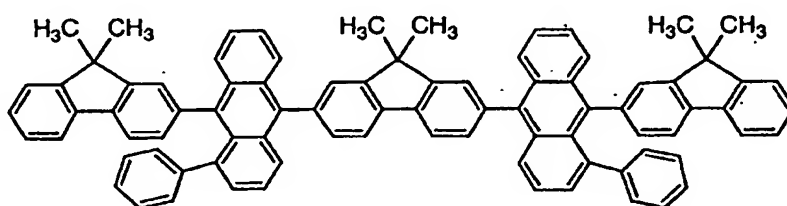
M-16



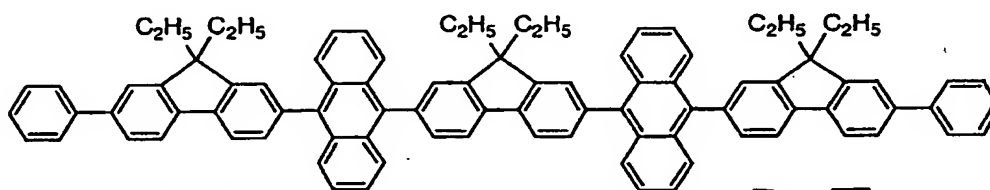
M-17



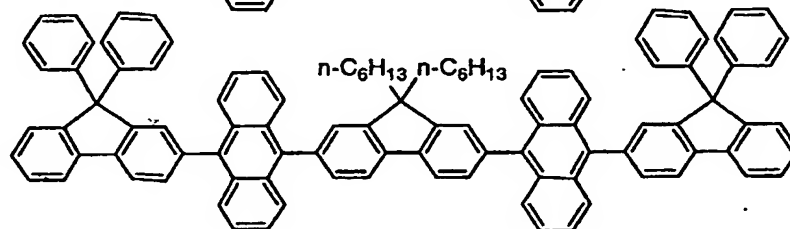
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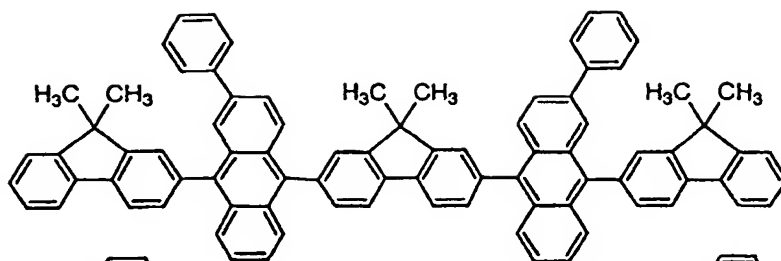
M-19



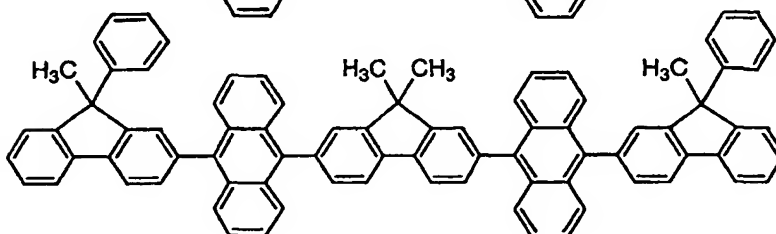
M-20



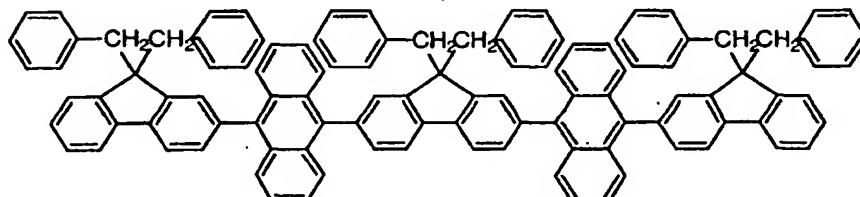
M-21



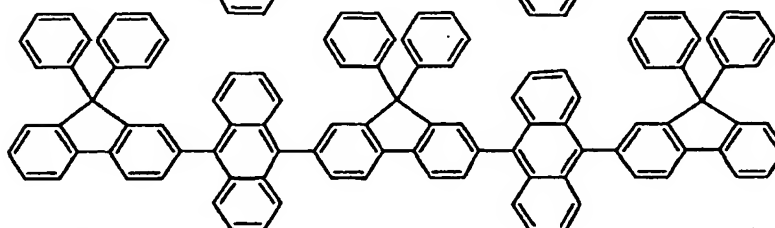
M-22



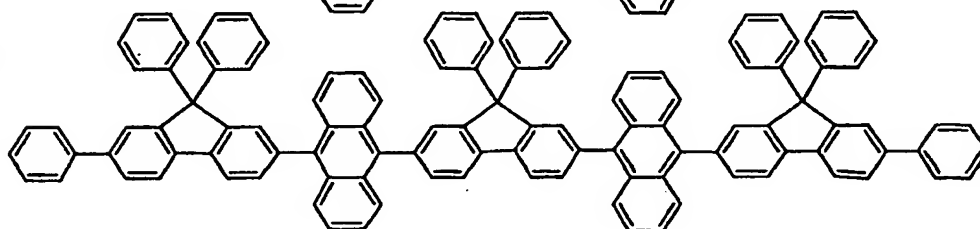
M-23



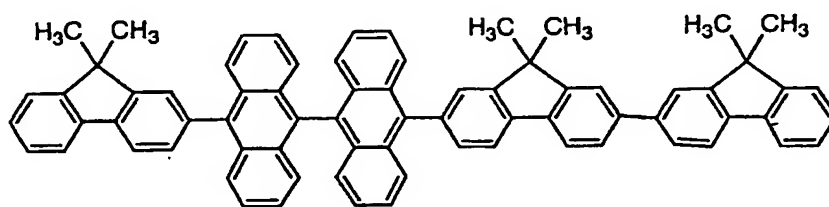
M-24



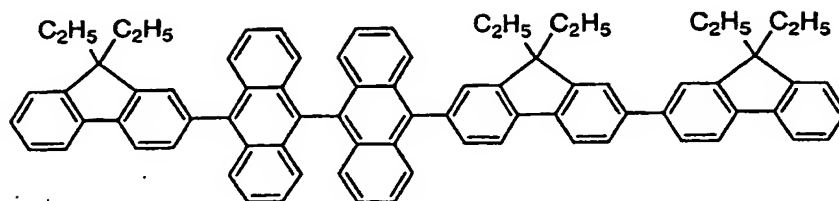
M-25



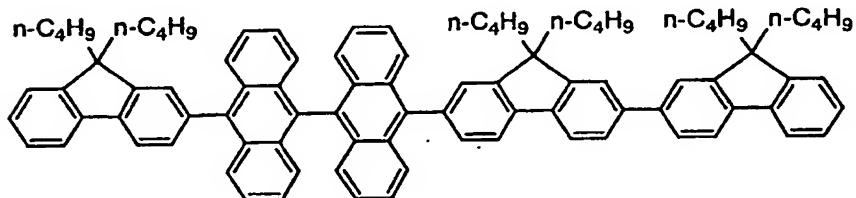
N-1



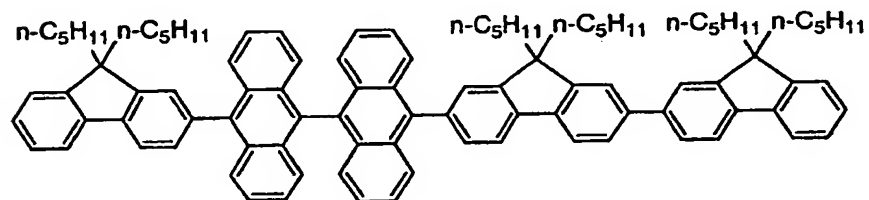
N-2



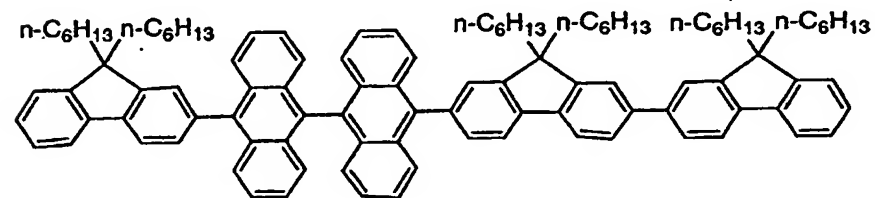
N-3



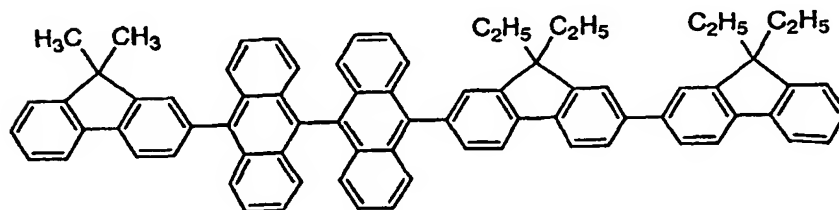
N-4



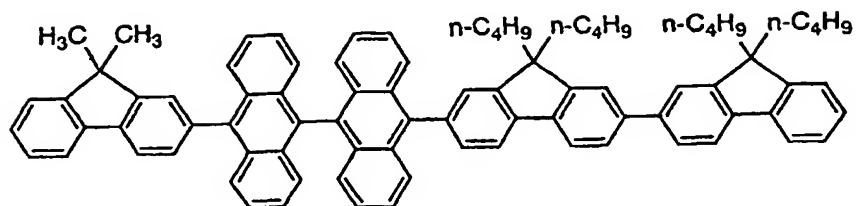
N-5



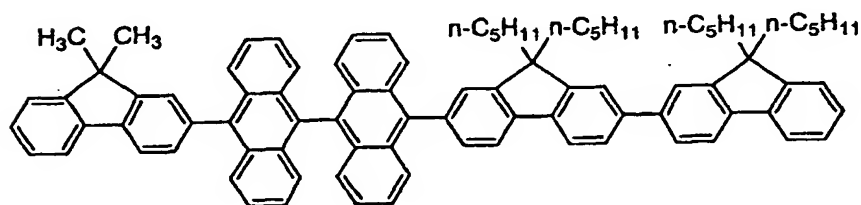
N-6



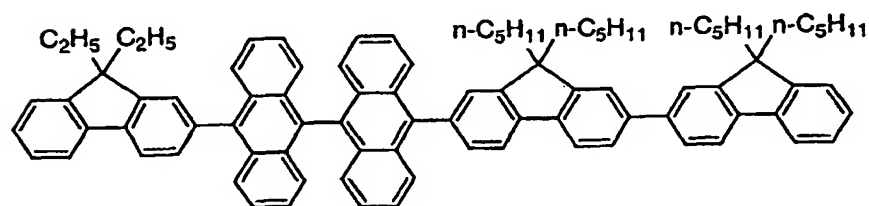
N-7



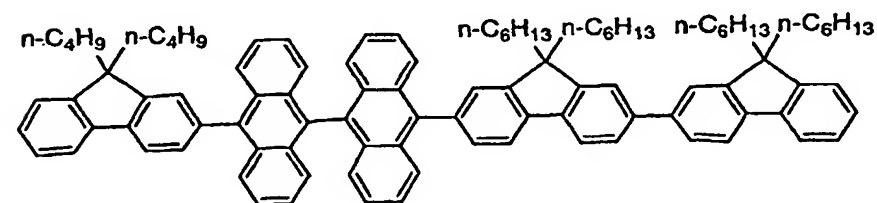
N-8



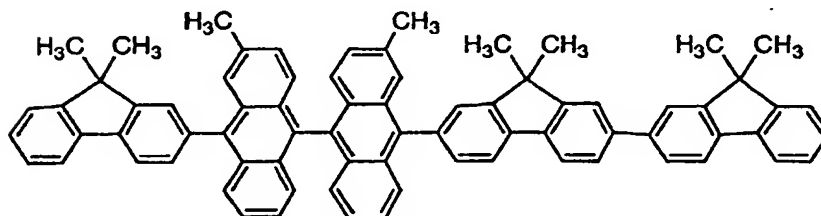
N-9



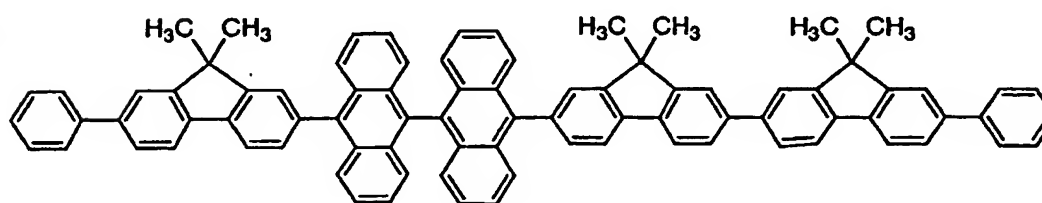
N-10



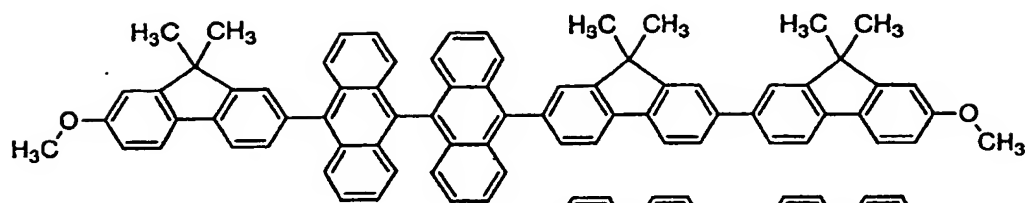
N-11



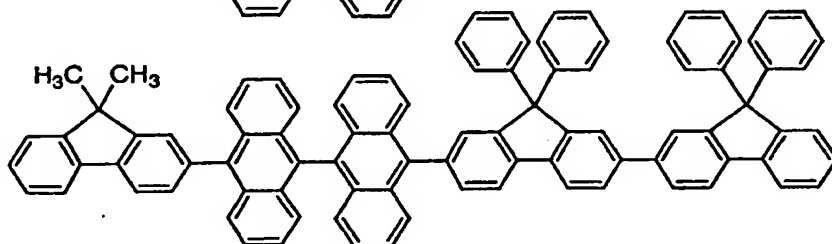
N-12



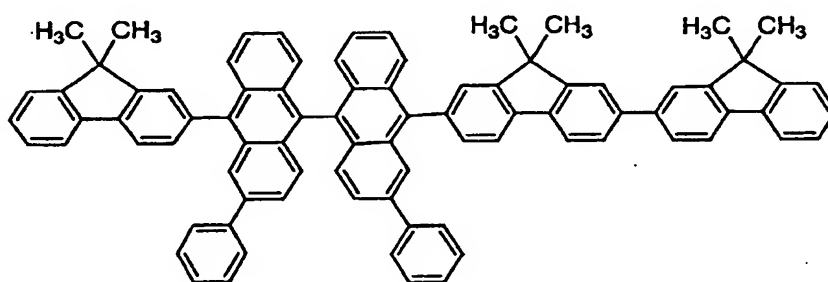
N-13



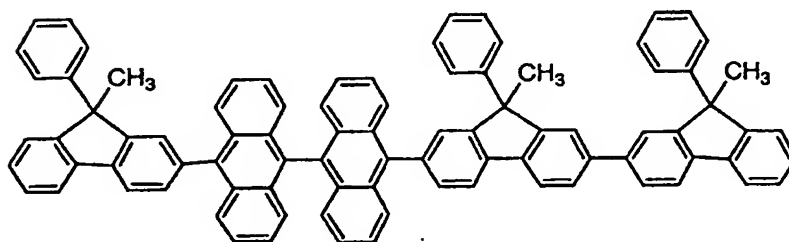
N-14



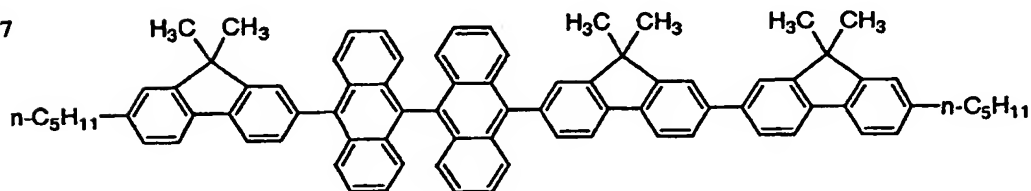
N-15

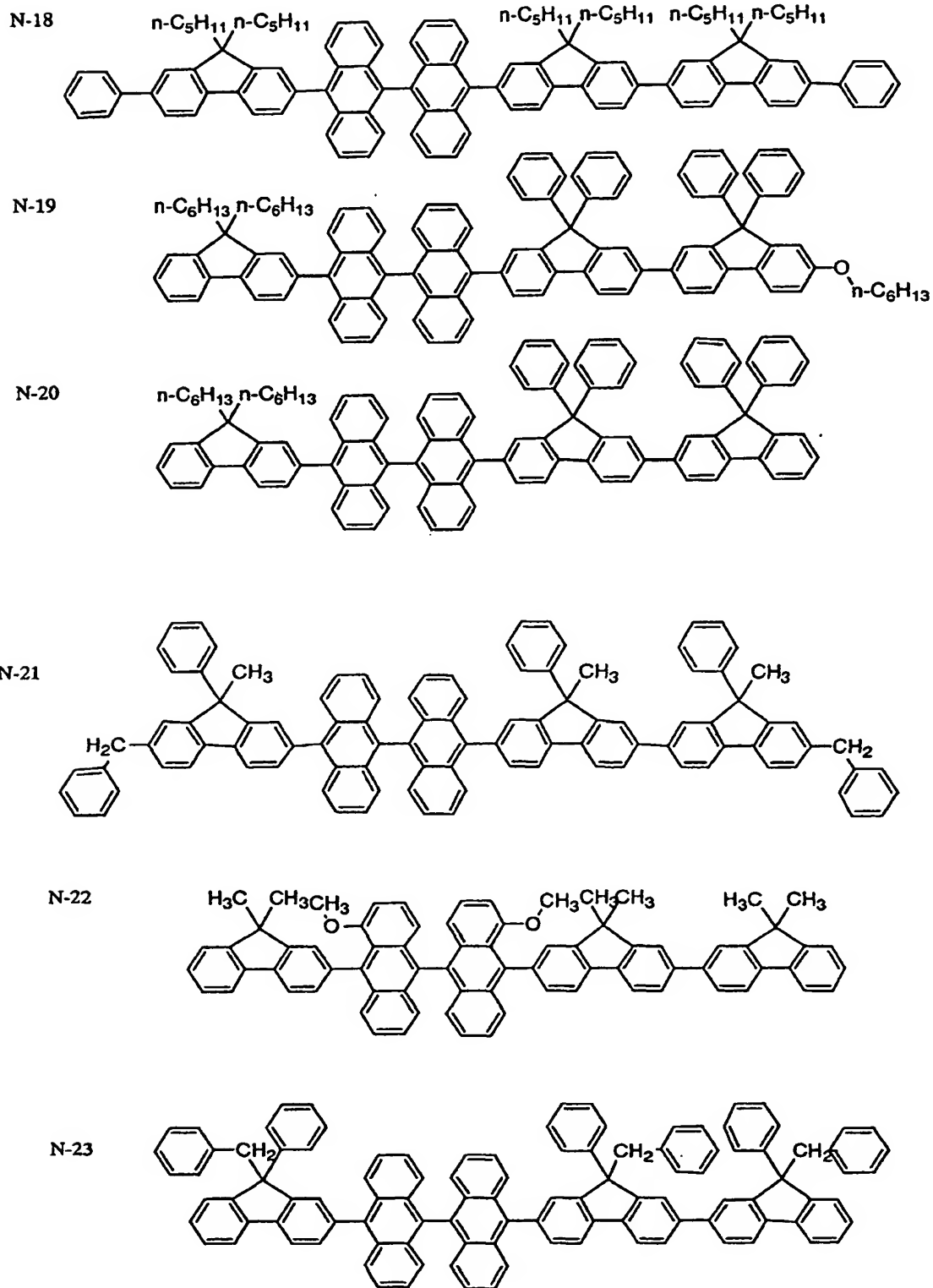


N-16

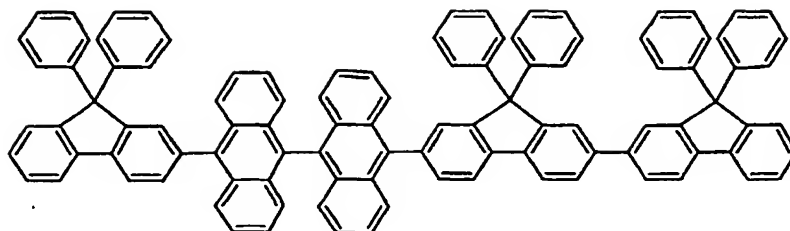


N-17

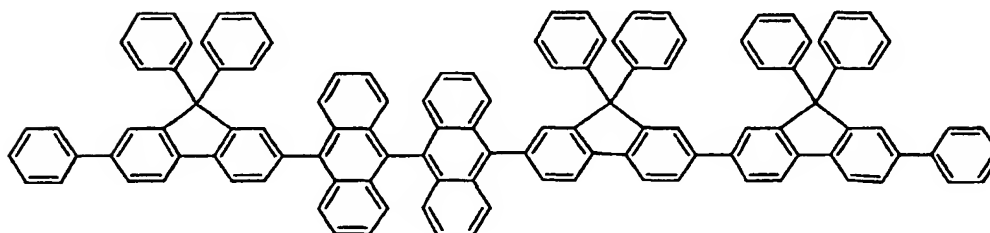




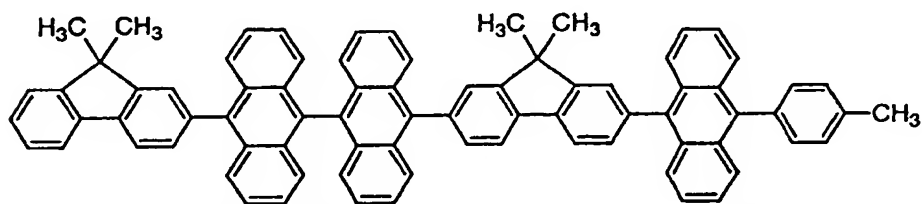
N-24



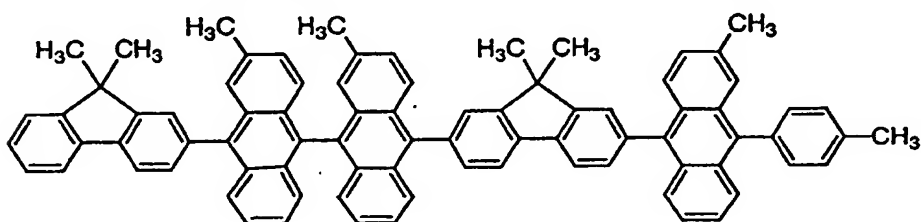
N-25



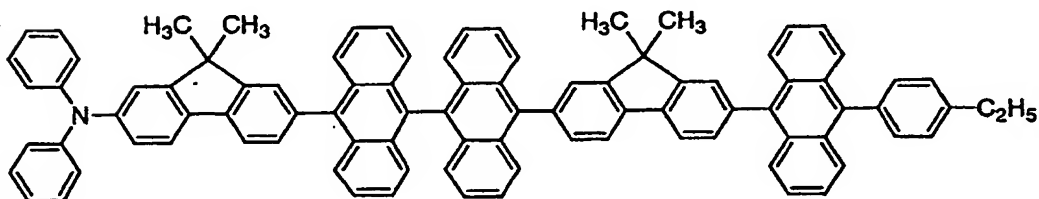
O-1

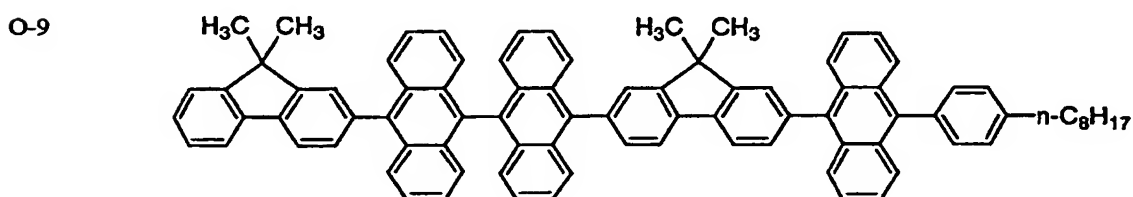
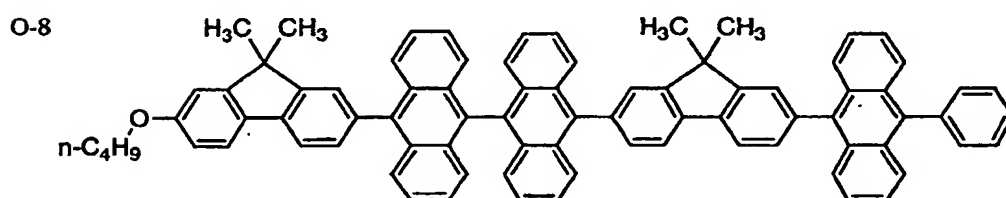
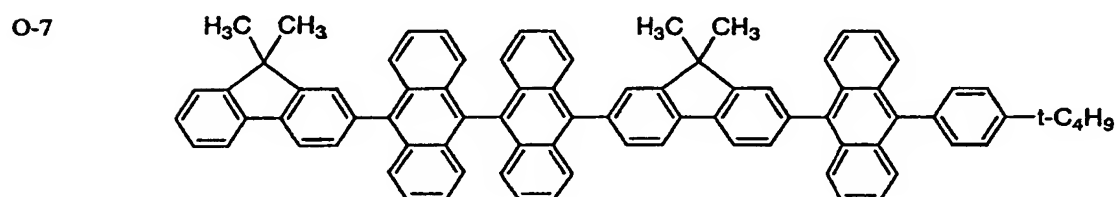
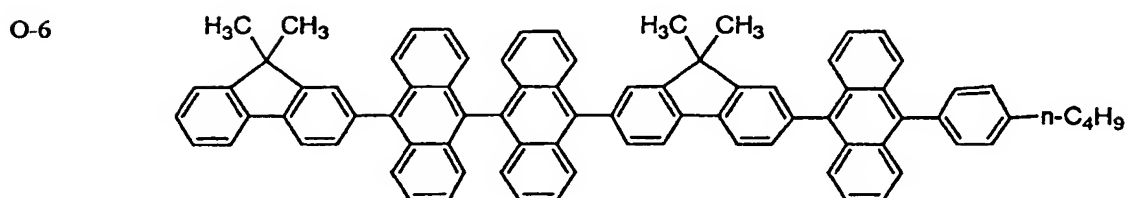
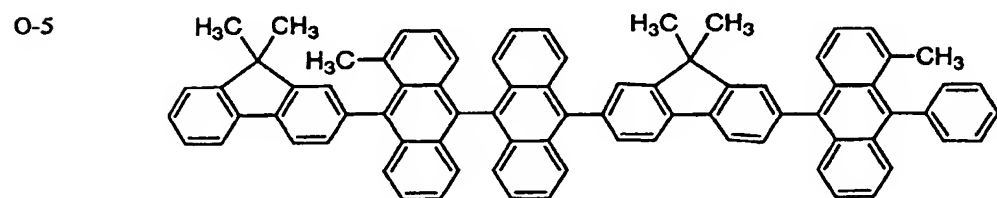
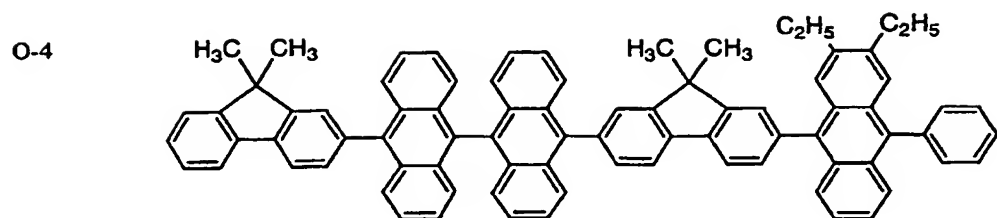


O-2

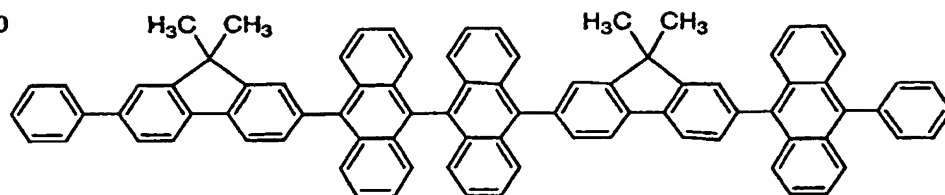


O-3

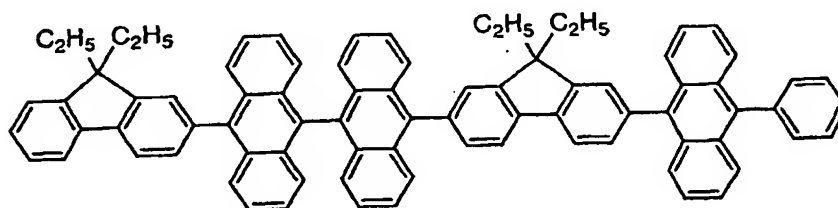




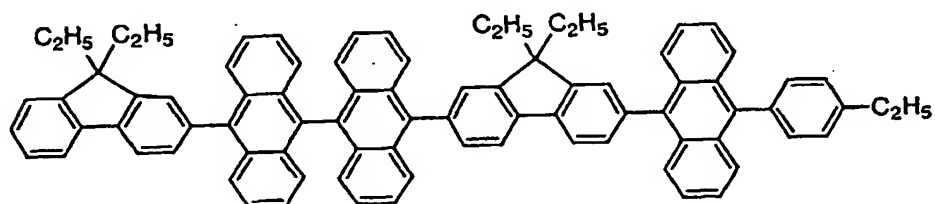
O-10



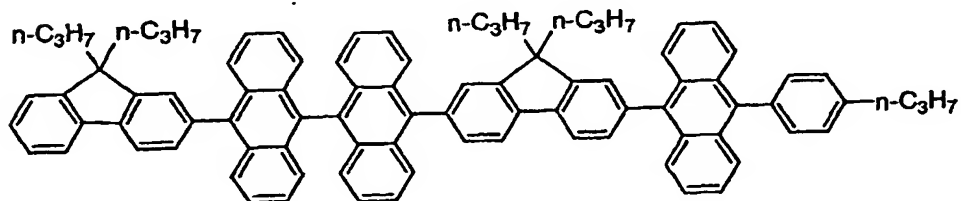
O-11



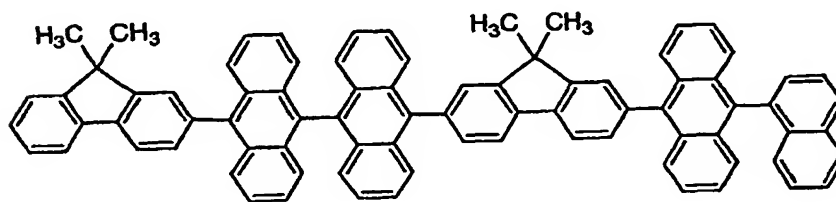
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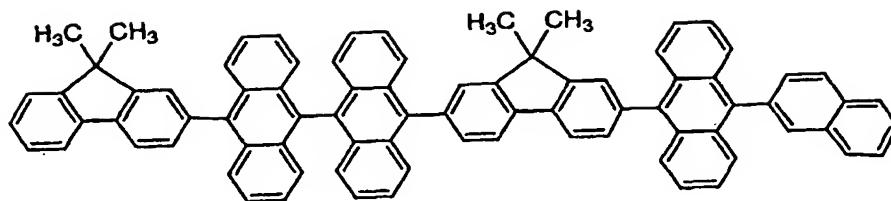
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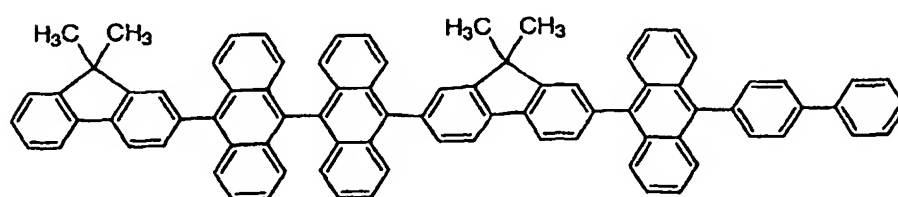
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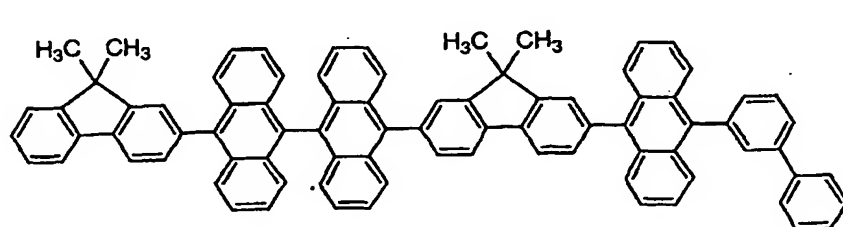
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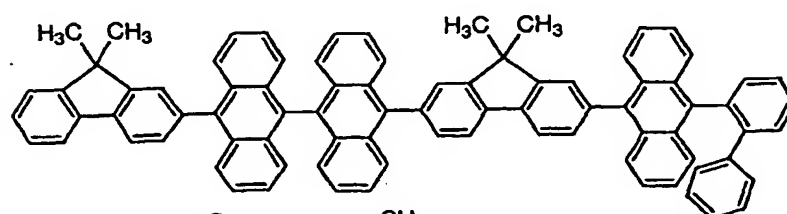
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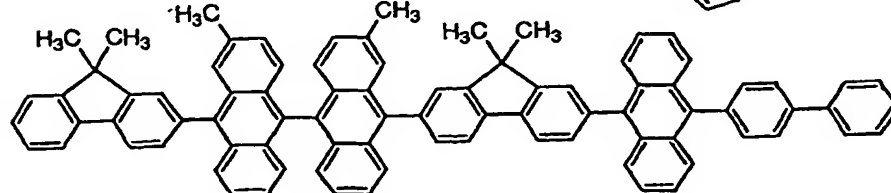
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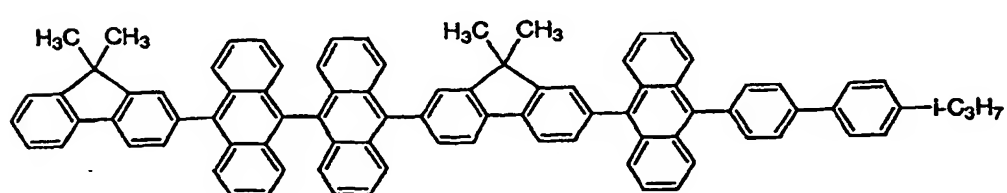
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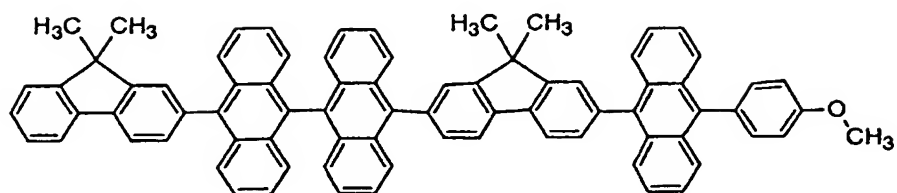
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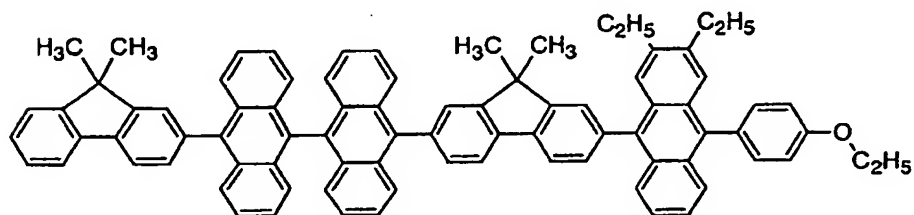
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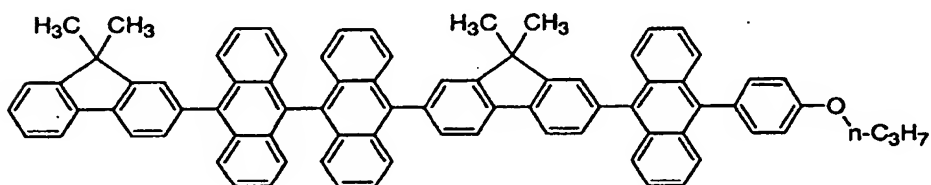
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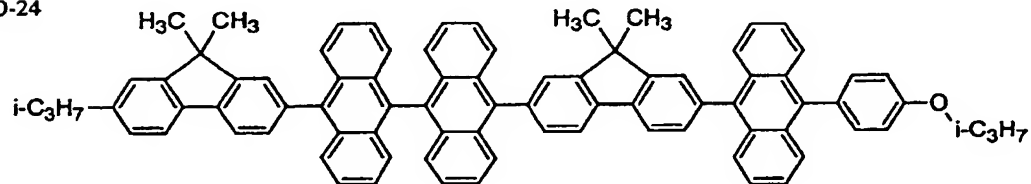
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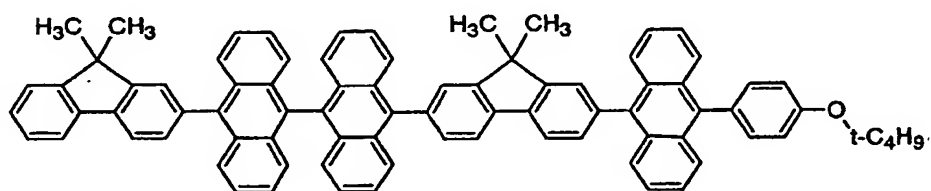
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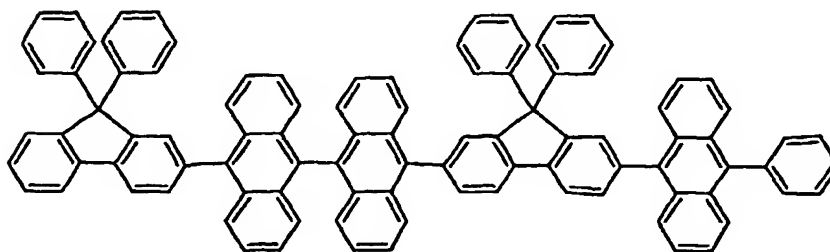
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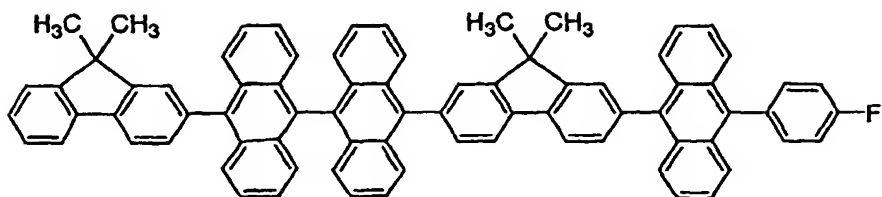
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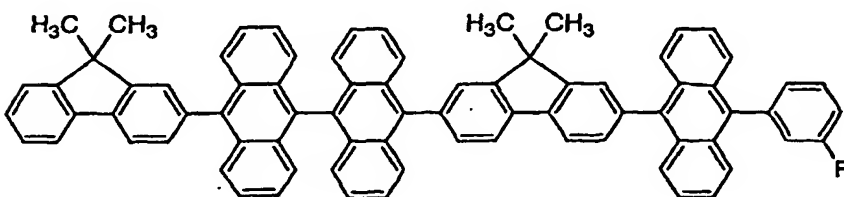
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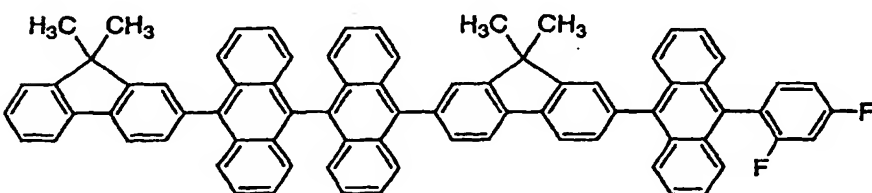
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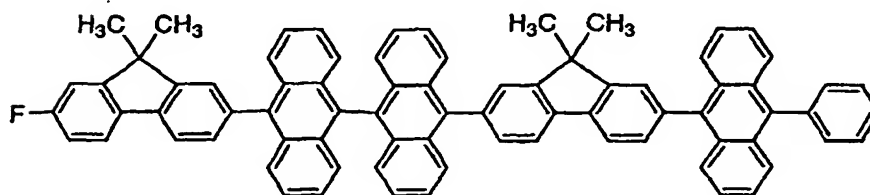
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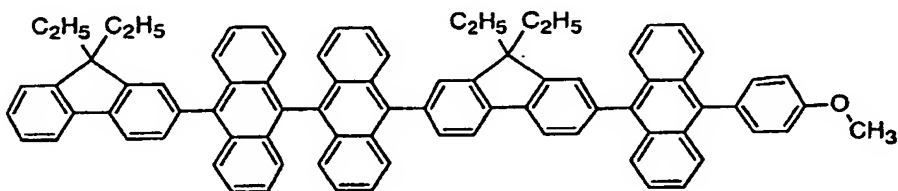
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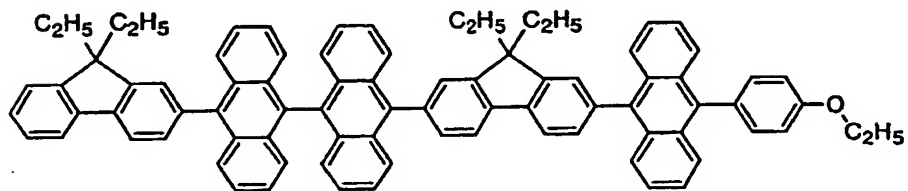
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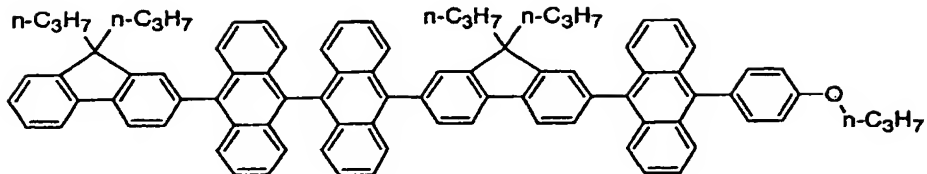
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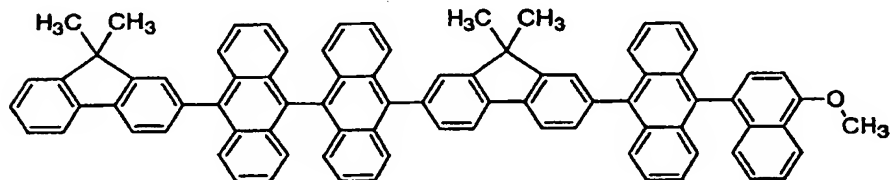
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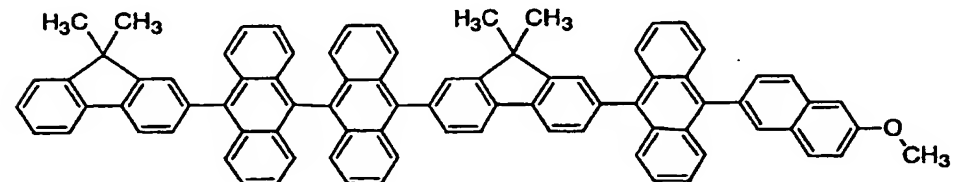
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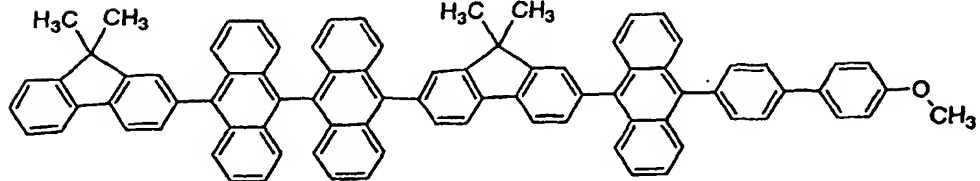
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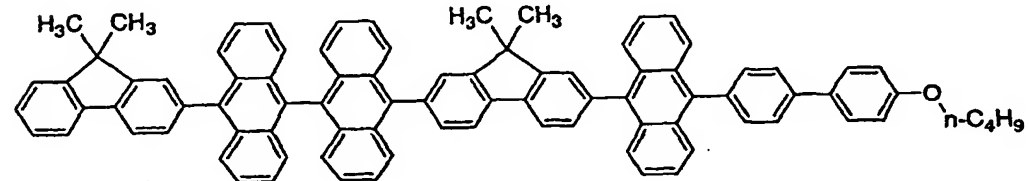
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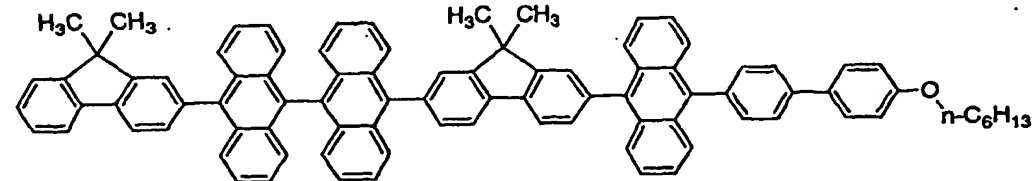
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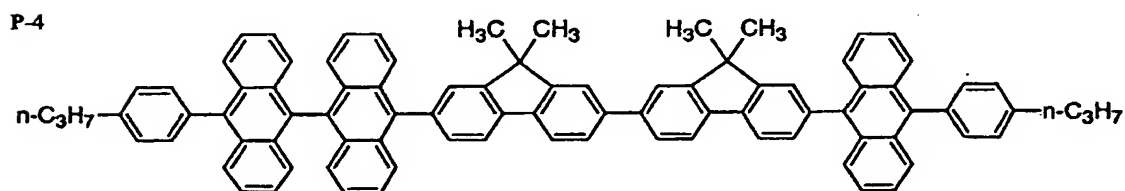
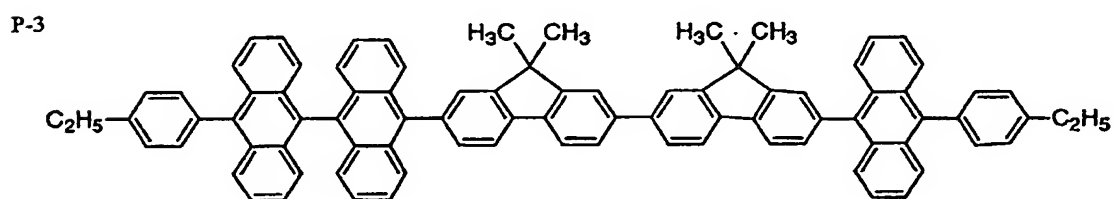
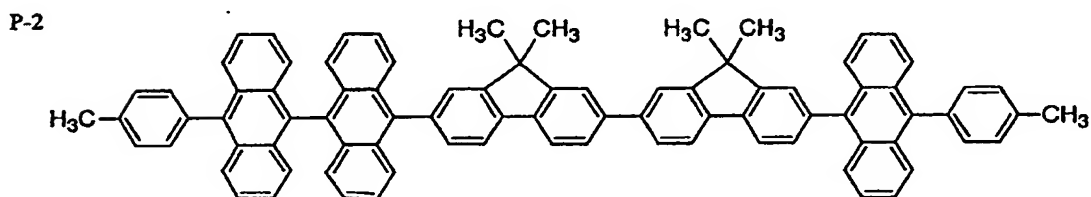
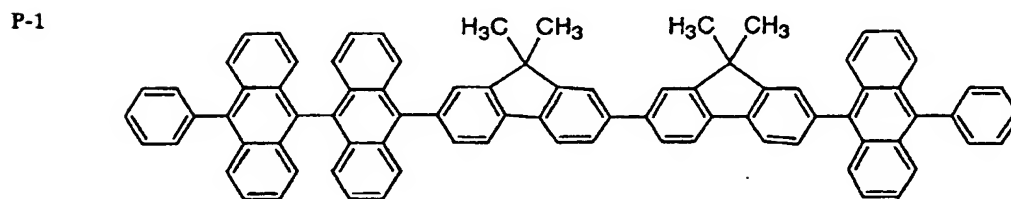
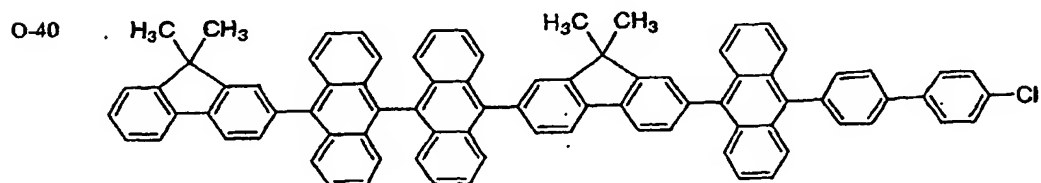
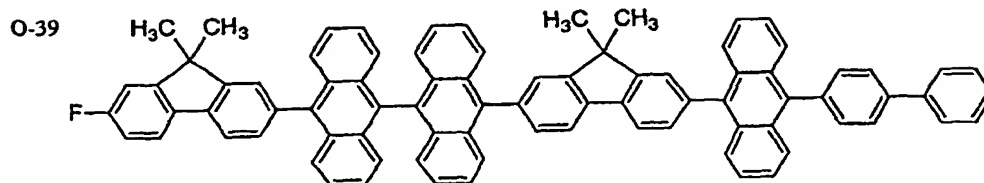


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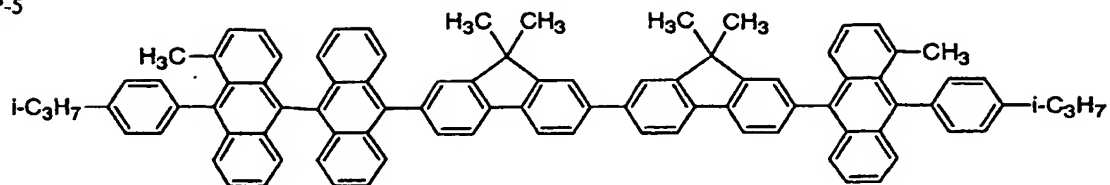


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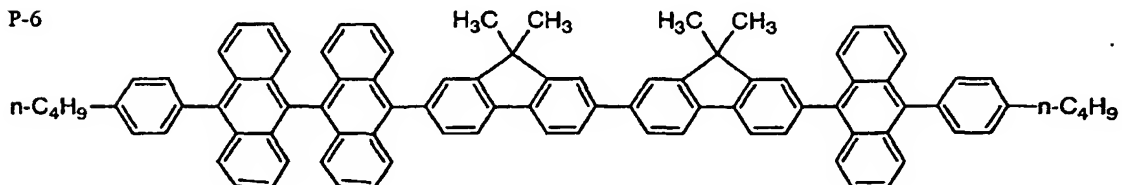




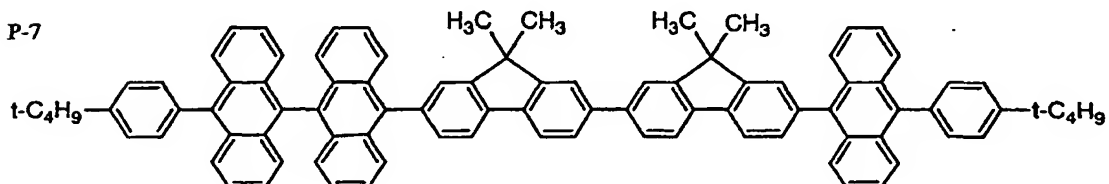
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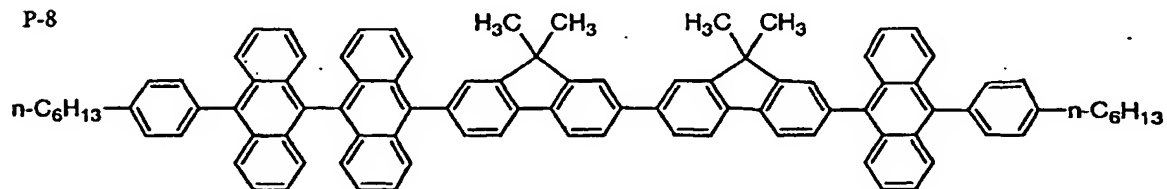
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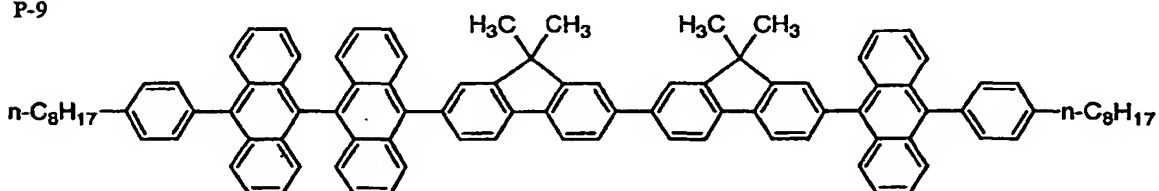
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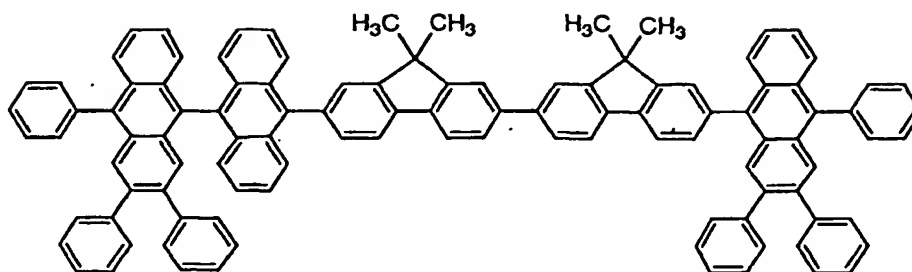
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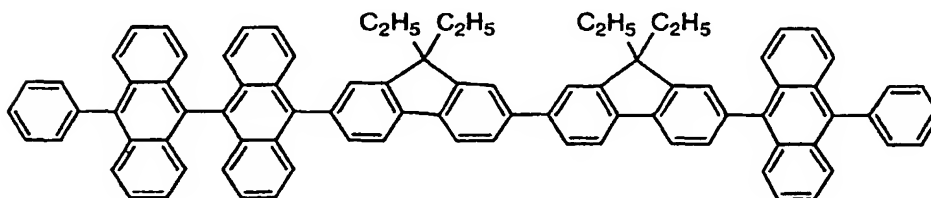
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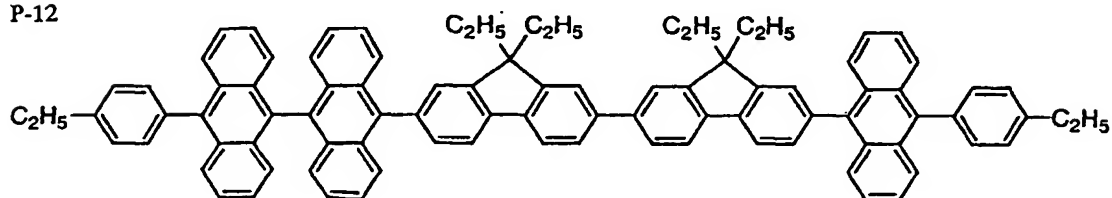
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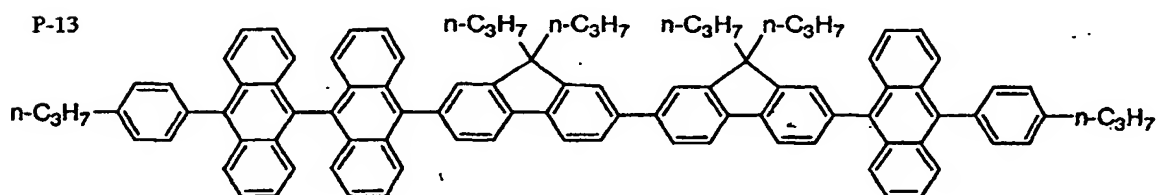
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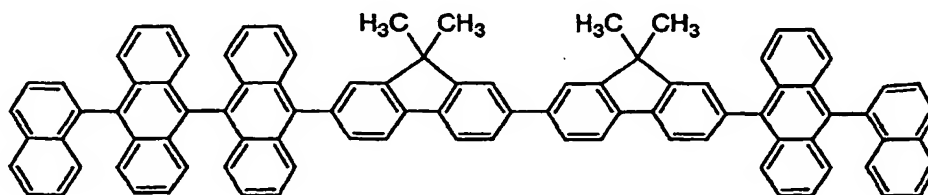
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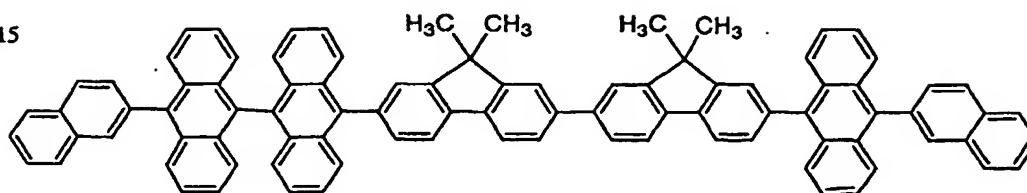
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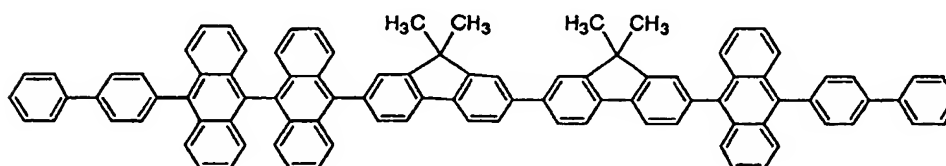
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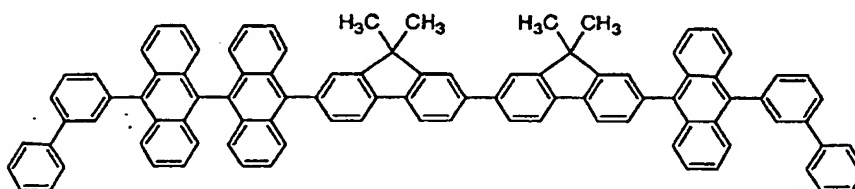
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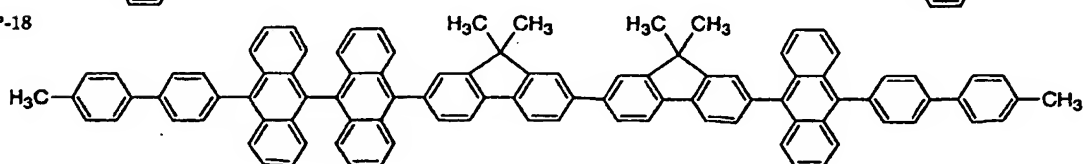
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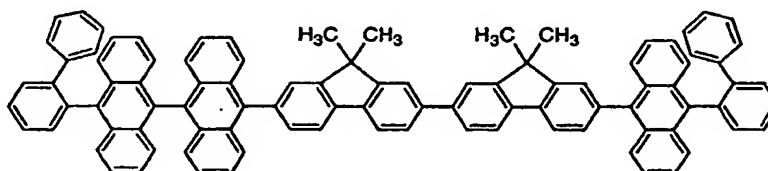
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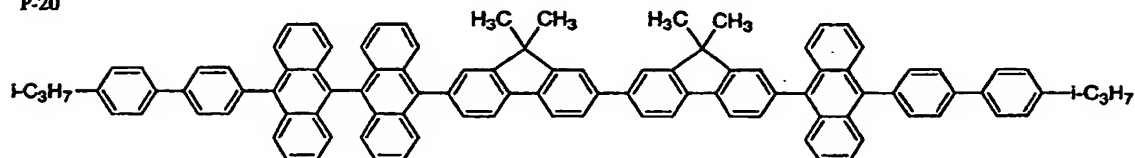
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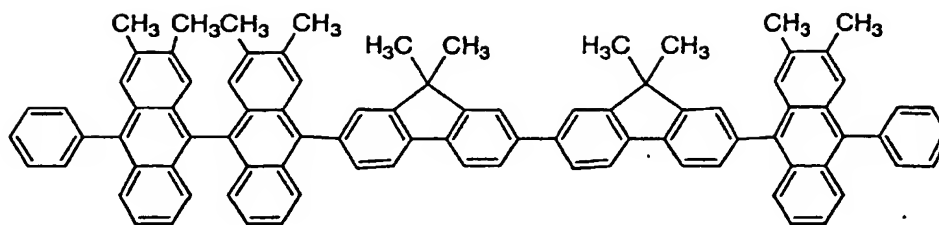
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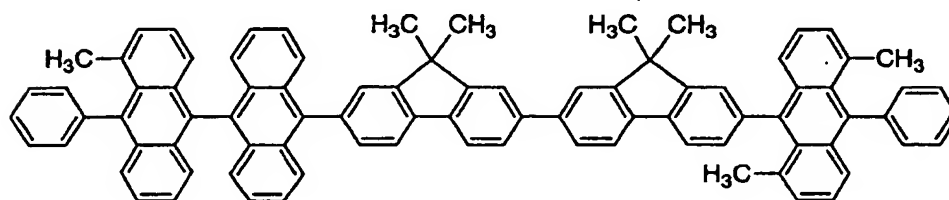
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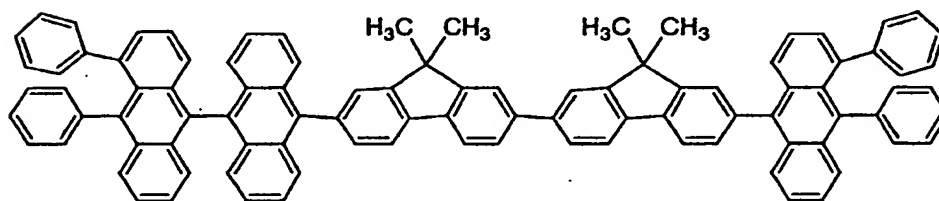
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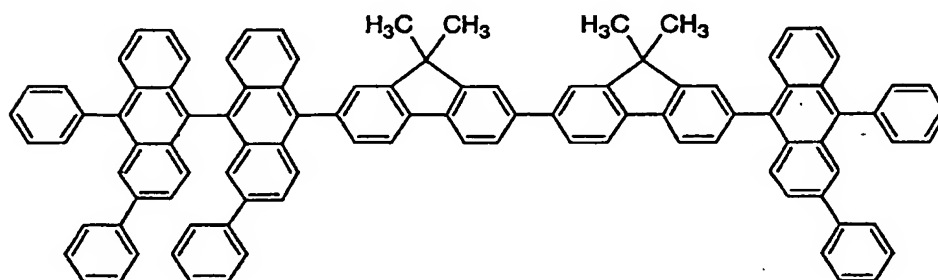
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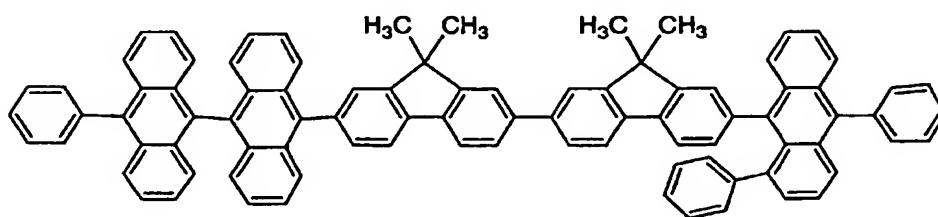
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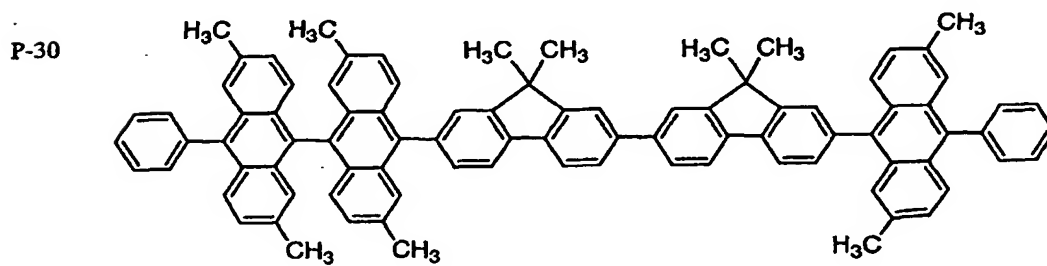
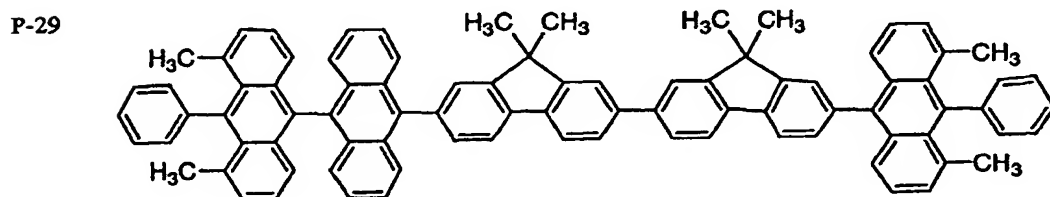
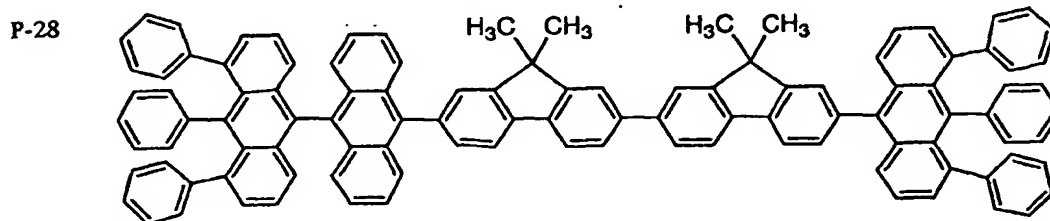
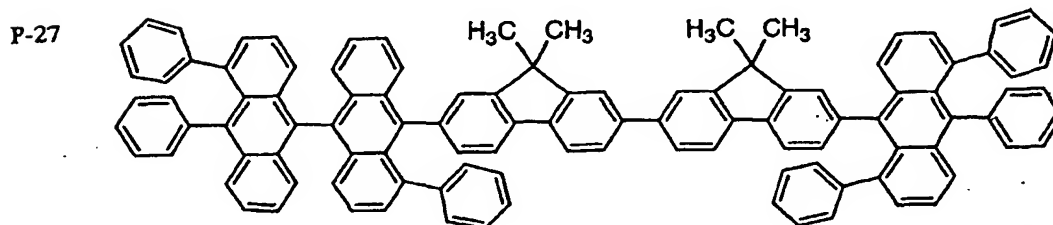
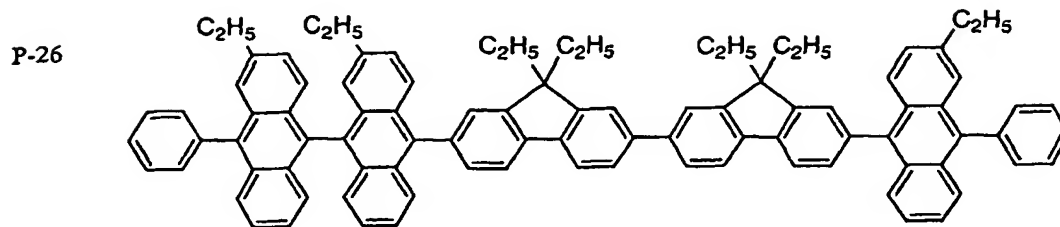


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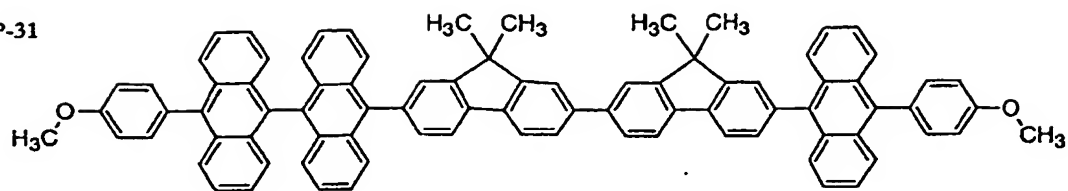


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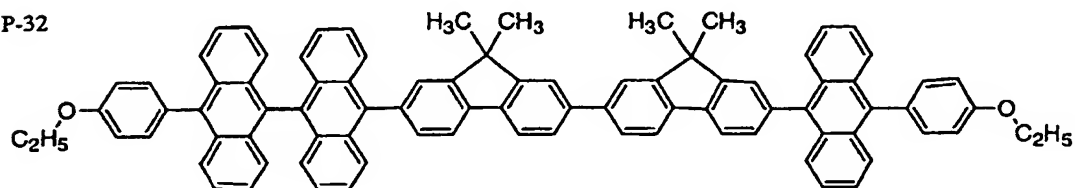




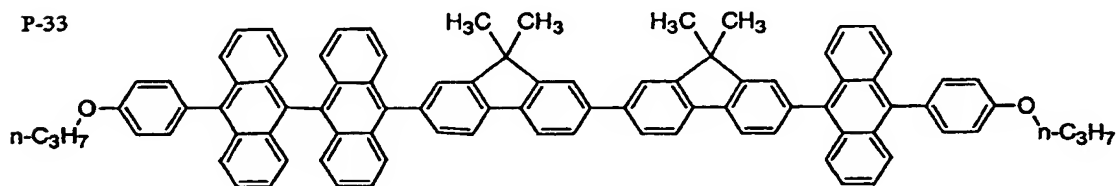
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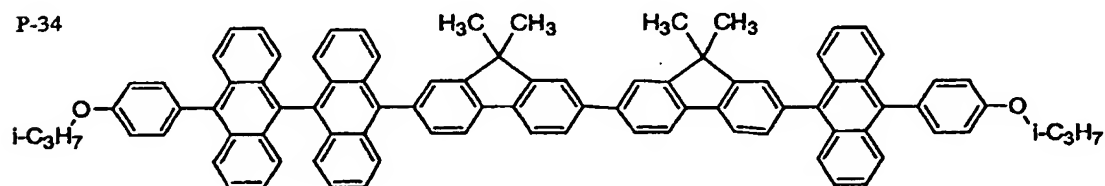
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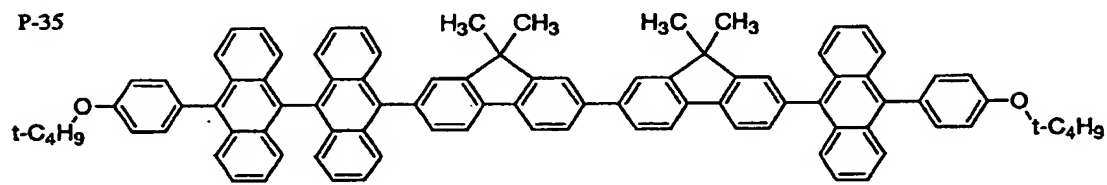
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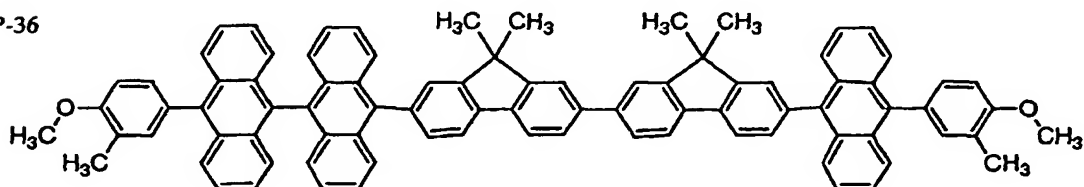
P-34



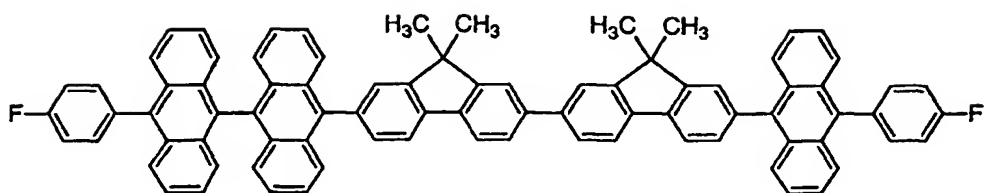
P-35



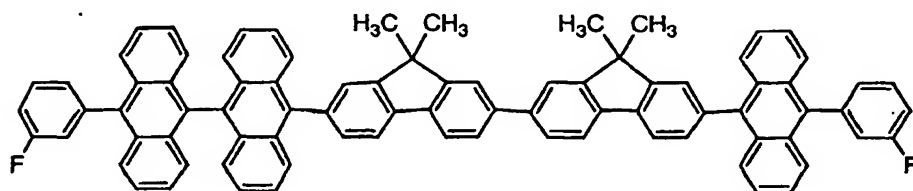
P-36



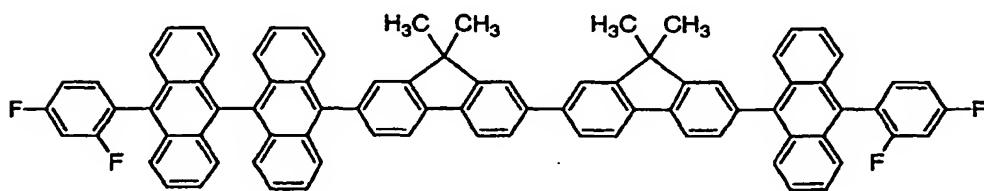
P-37



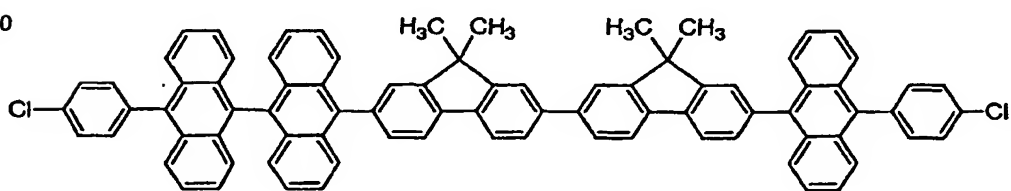
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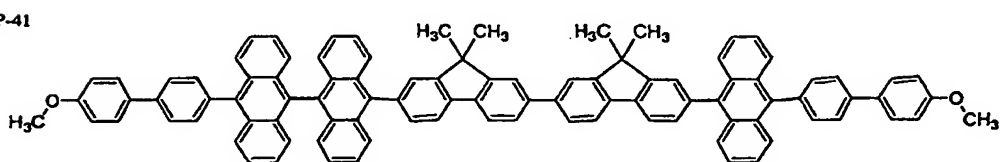
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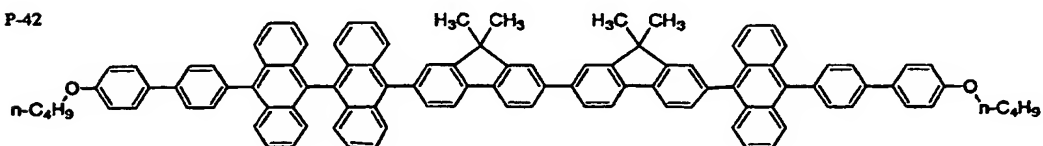
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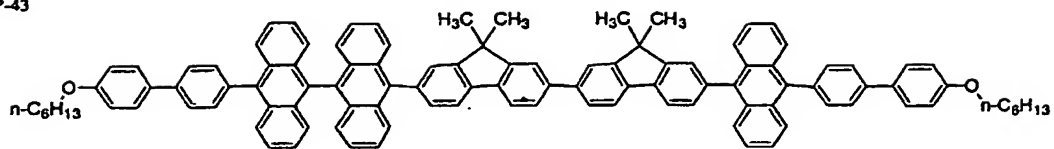
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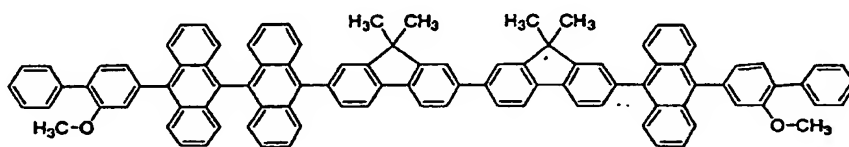
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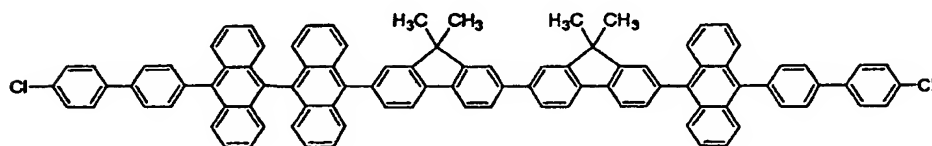
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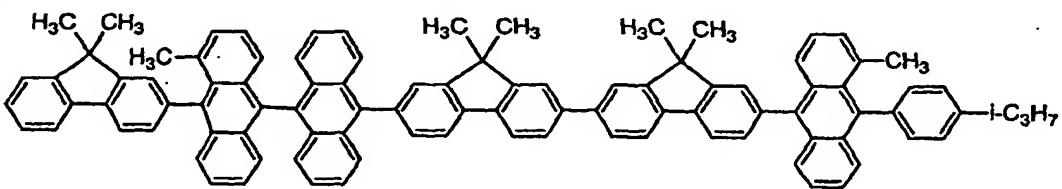
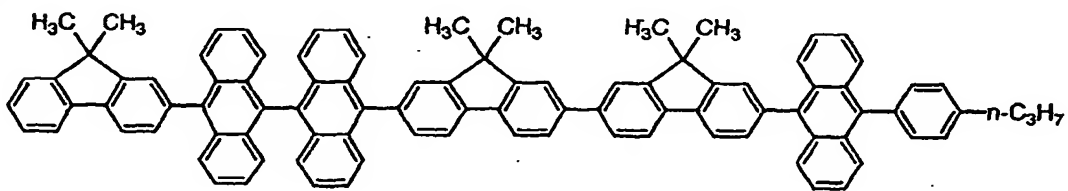
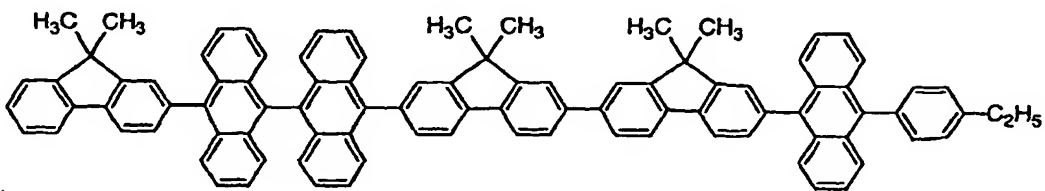
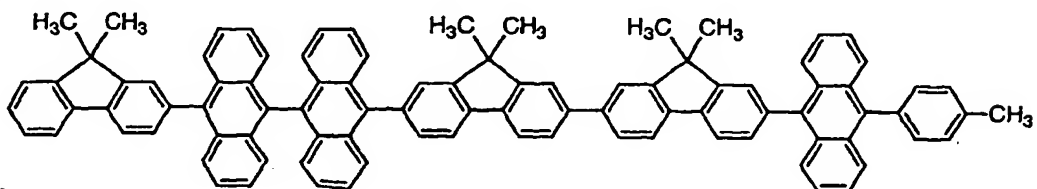
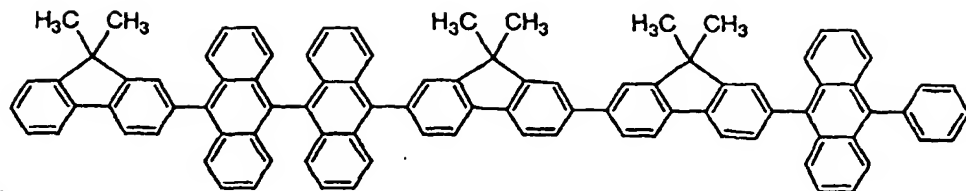


P-44

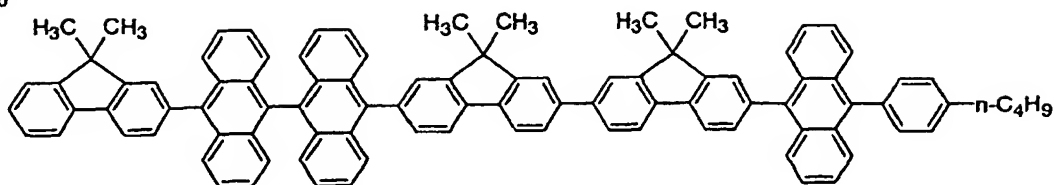


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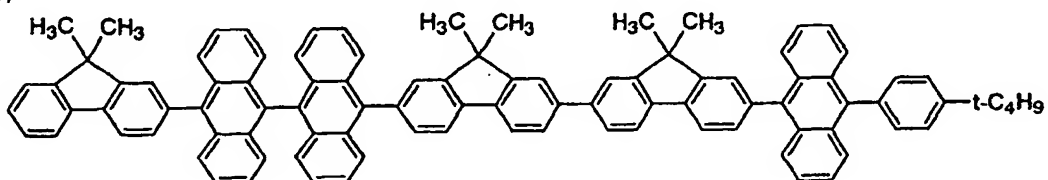




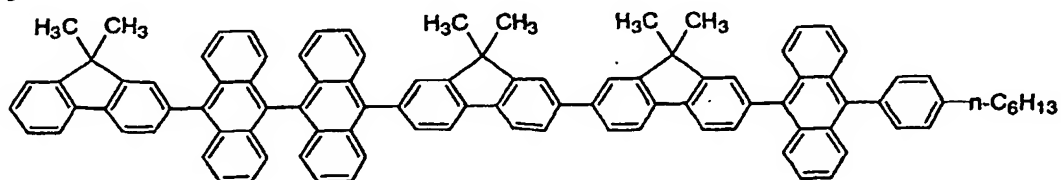
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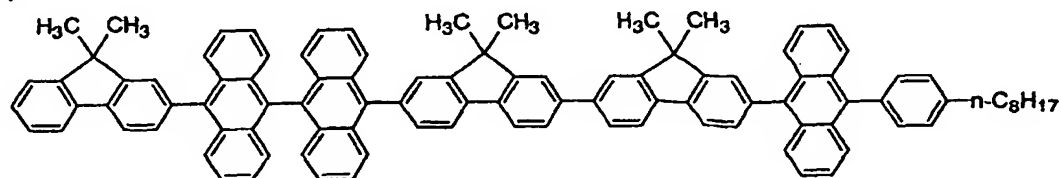
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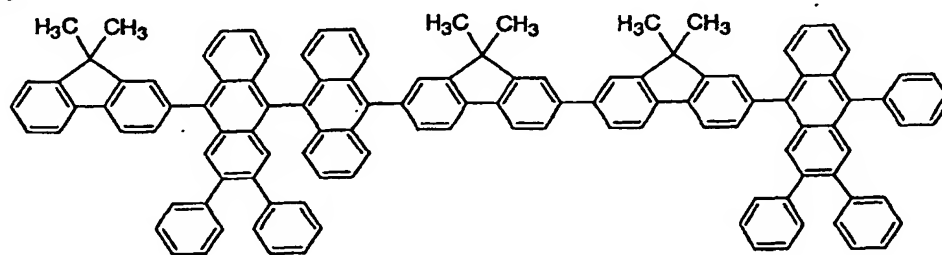
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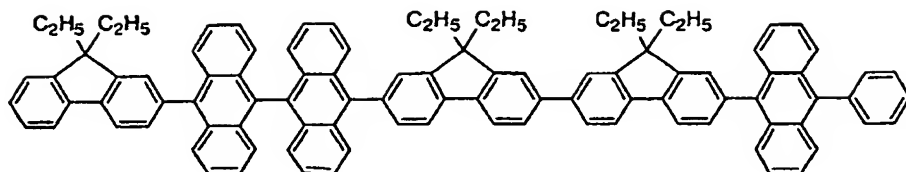
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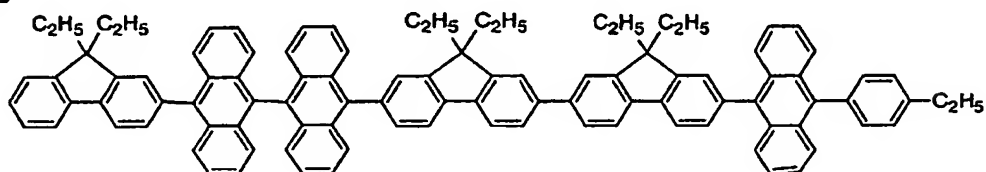
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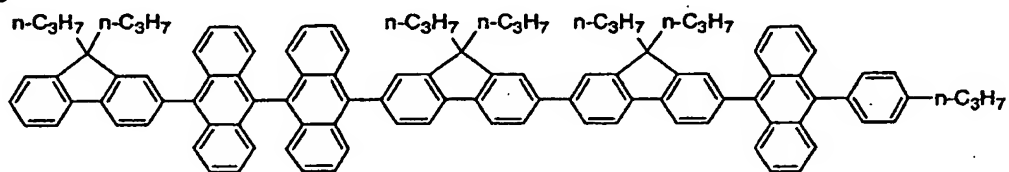
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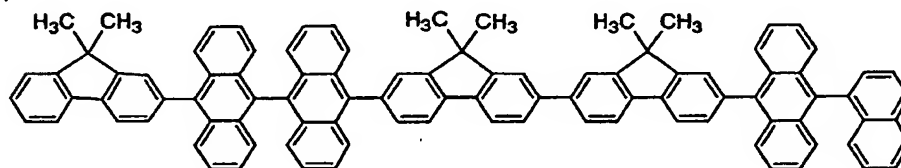
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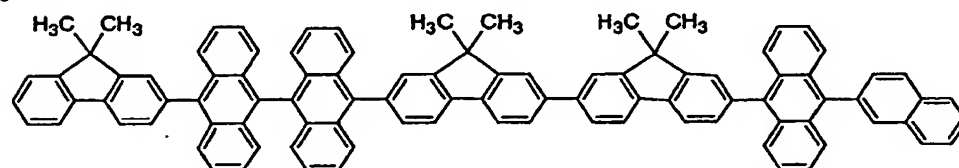
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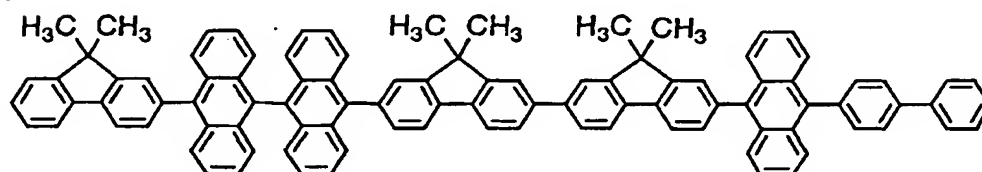
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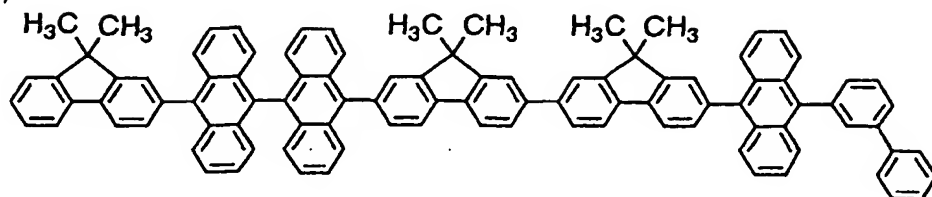
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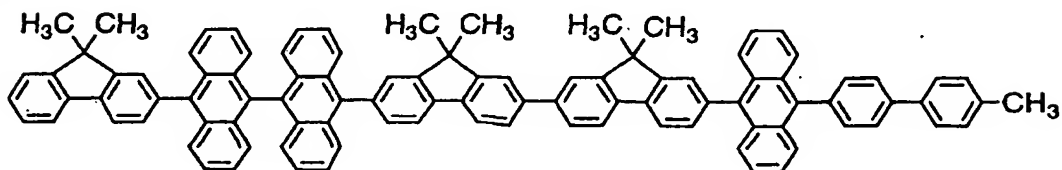
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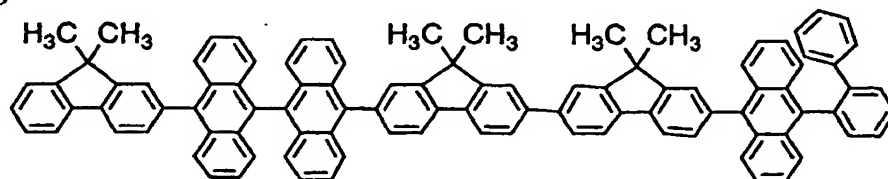
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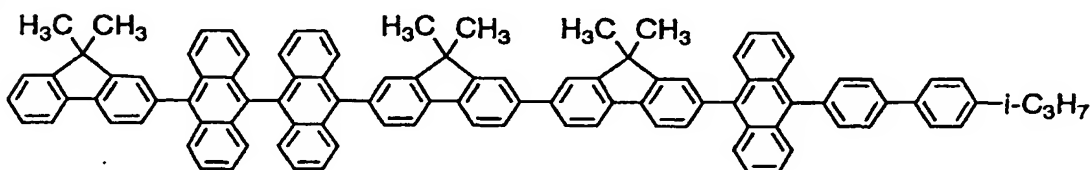
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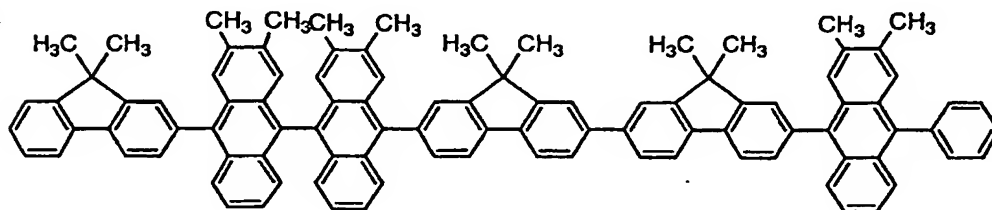
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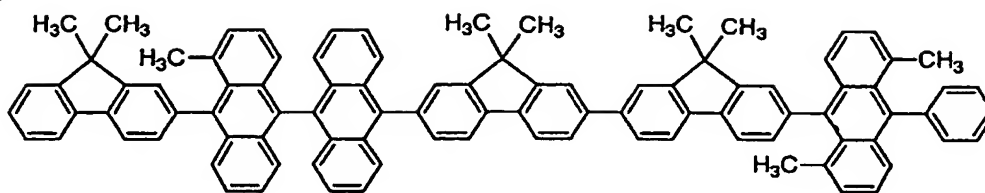
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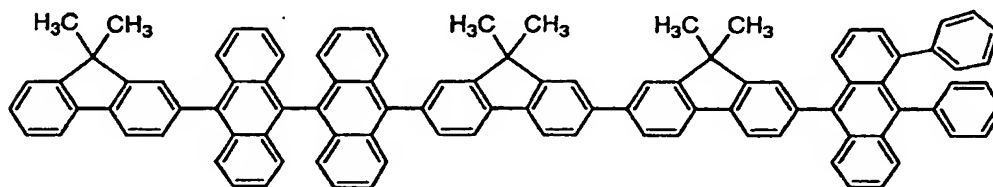
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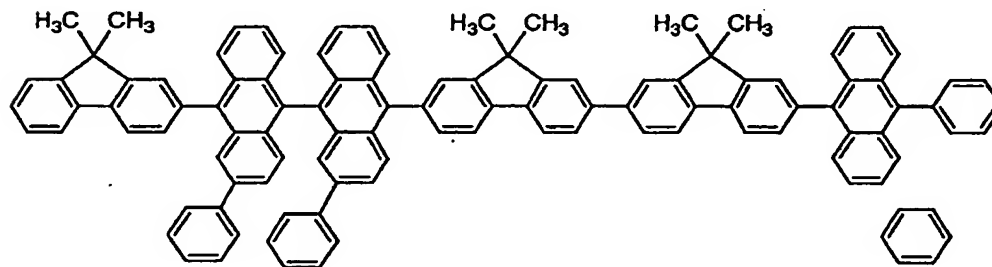
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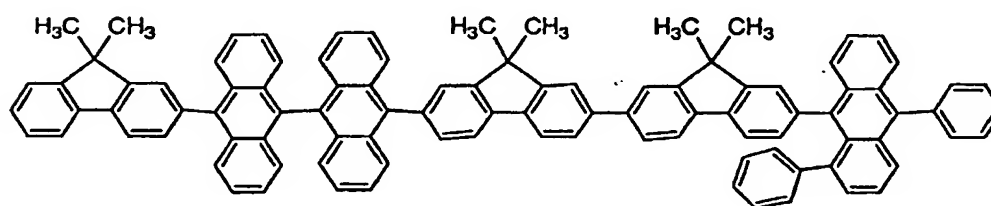
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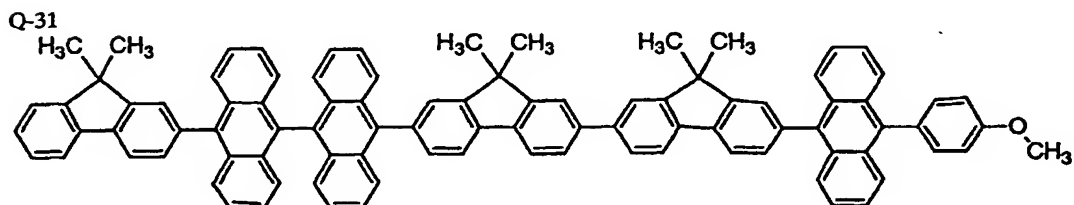
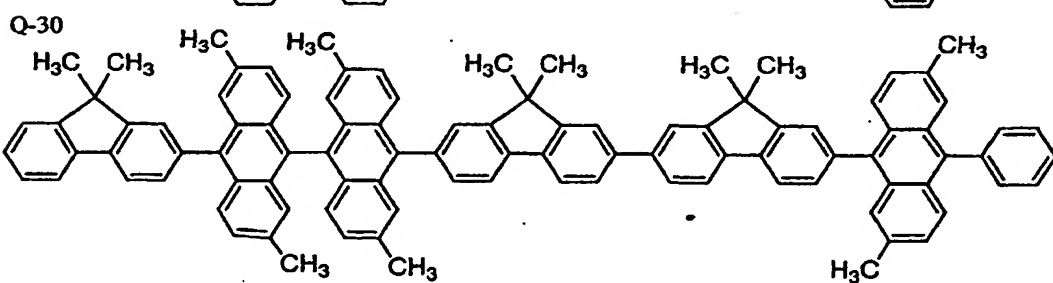
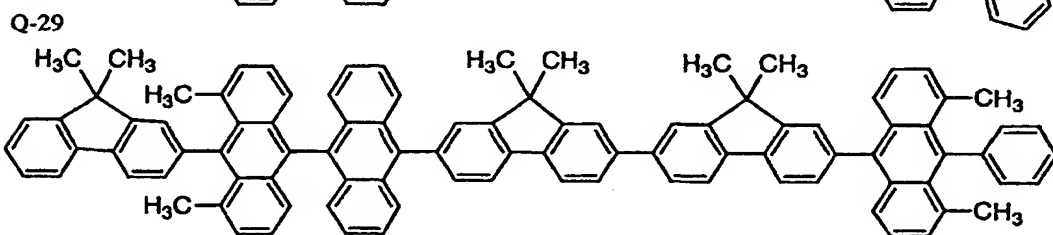
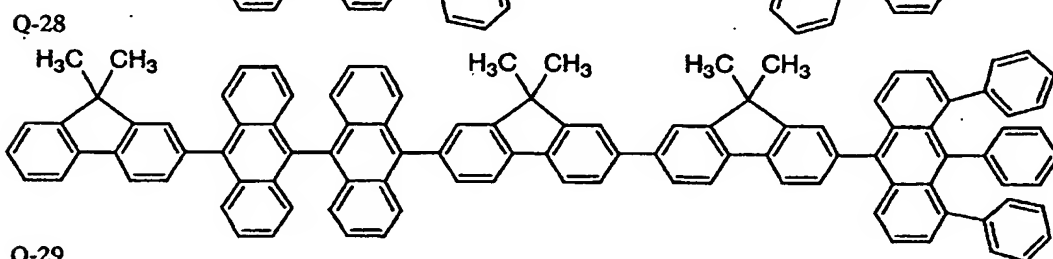
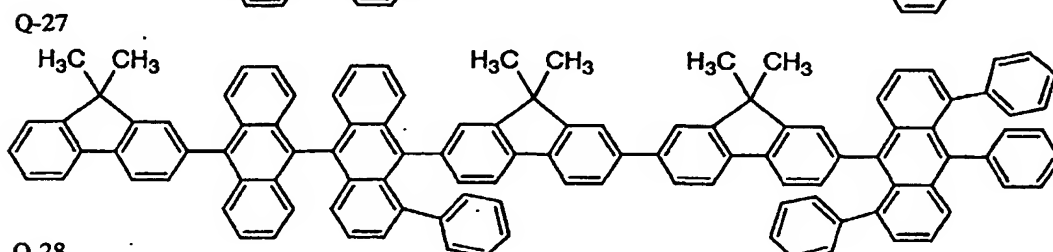
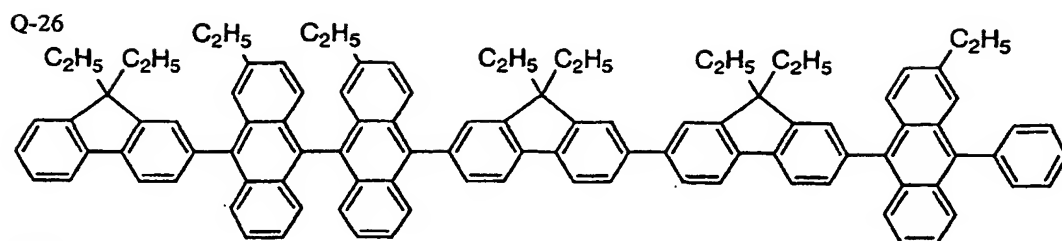


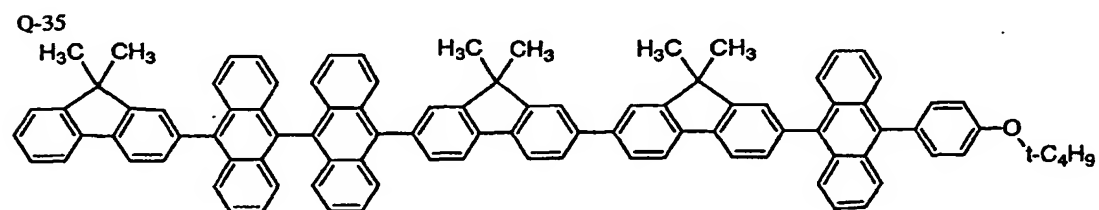
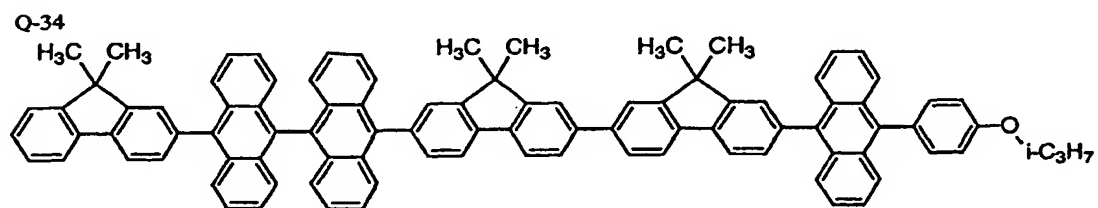
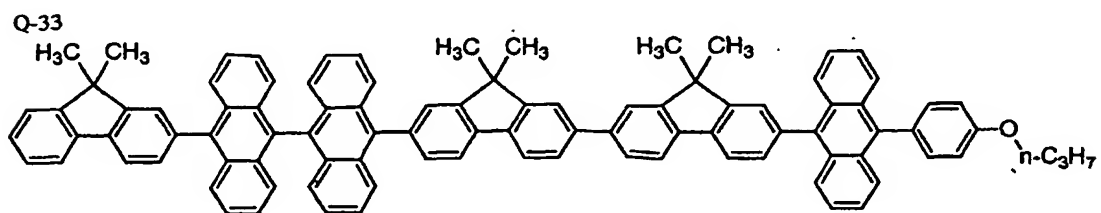
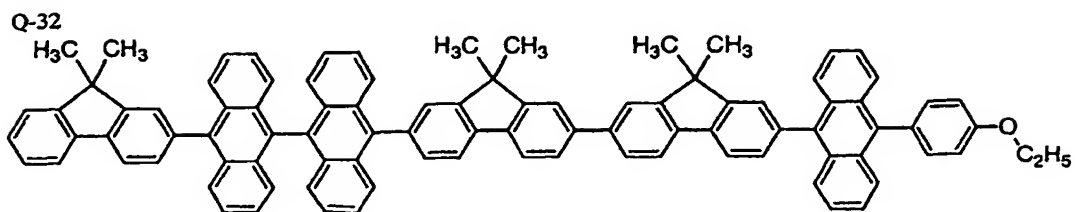
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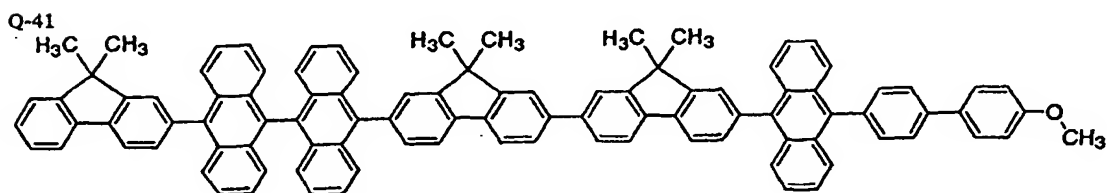
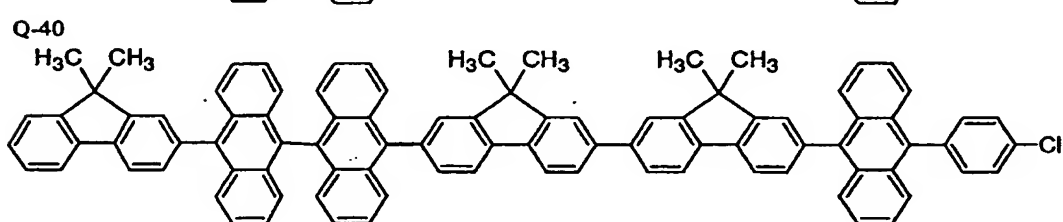
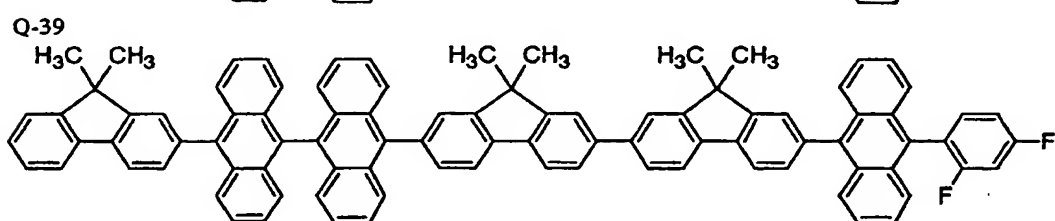
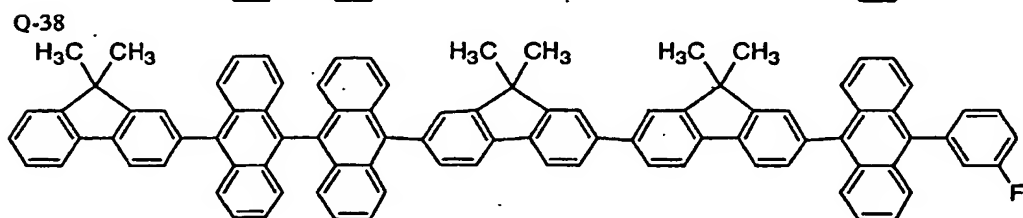
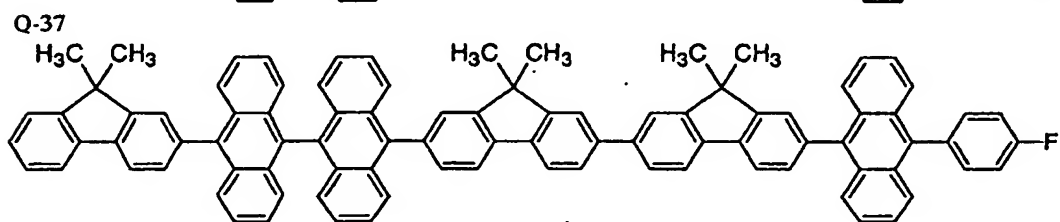
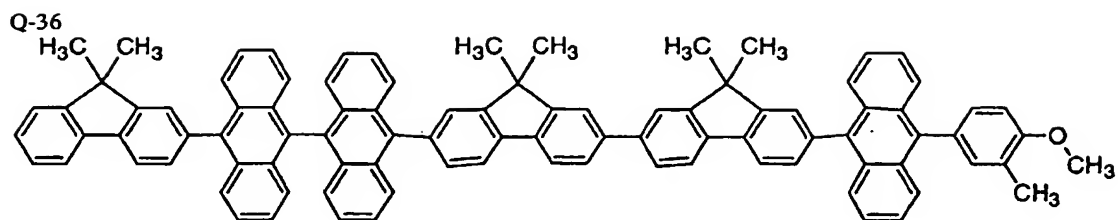


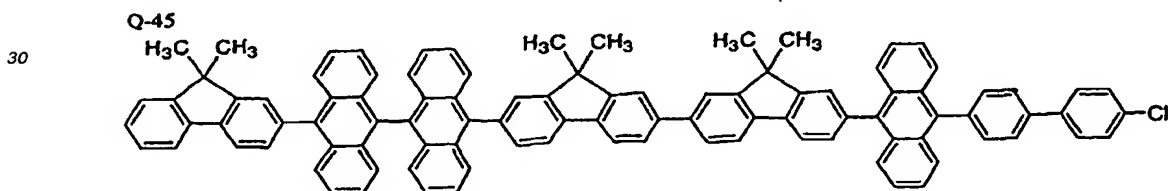
Q-25











[0053] That is, for example, compounds A can be produced by reacting boric acid compounds represented by the following the formula (7) with compounds represented by the following the formula (8) in the presence of, for example, palladium compounds [for example, tetrakis(triphenylphosphine)palladium and bis(triphenylphosphine)palladium chloride] and bases (for example, sodium carbonate, sodium hydrogencarbonate and triethylamine) [for example, the process described in Chem. Rev., 95, 2457 (1995) can be referred to].



wherein A_1 , A_2 , F_1 , F_2 , F_3 , X_1 , X_2 , j , k , l , m and n have the same meanings as in the formula (1), and Y_1 represents a halogen atom.

[0054] In the formula (8), Y_1 represents a halogen atom, preferably, a chlorine atom, a bromine atom or an iodine atom.

[0055] Further, the compounds represented by the formula (1) can be produced by, for example, reacting compounds represented by the following the formula (9) with boric acid compounds represented by the following the formula (10) in the presence of, for example, palladium compounds [for example, tetrakis(triphenylphosphine)palladium and bis(triphenylphosphine)palladium dichloride] and bases (for example, sodium carbonate, sodium hydrogencarbonate and triethylamine) [for example, the process described in Chem. Rev., 95, 2457 (1995) can be referred to].



wherein A_1 , A_2 , F_1 , F_2 , F_3 , X_1 , X_2 , j , k , l , m and n have the same meanings as in the formula (1), and Y_2 represents a halogen atom.

[0056] In the formula (9), Y_2 represents a halogen atom, preferably, a chlorine atom, a bromine atom or an iodine atom.

[0057] Incidentally, the compounds represented by the formula (7) and the formula (10) can be produced by, for example, reacting compounds represented by the formula (9) and the formula (8) with a lithio compound or a Grignard reagent that can be formed by a reaction of *n*-butyl lithium and metallic magnesium and, for example, trimethoxyborane, triisopropoxyborane or the like.

[0058] Further, of the compounds represented by the formula (1), the compounds in which A_1 is a substituted or unsubstituted anthracen-9,10-diyl group can be produced by, for example, the following process. That is, of the compounds represented by the formula (1), the compounds in which A_1 is a substituted or unsubstituted anthracen-9,10-diyl group and k is 1 can be produced by dehydro-aromatizing compounds obtained by reacting compounds represented by the formula (8) and the following formula (11) with a lithio compound or a Grignard reagent that can be formed by a reaction of *n*-butyl lithium and metallic magnesium and substituted or unsubstituted anthraquinone in the presence of an acid (for example, hydriodic acid).



wherein F_1 , X_1 and j have the same meanings as in the formula (1), and Y_3 represents a halogen atom.

[0059] In the formula (11), Y_3 represents a halogen atom, preferably a chlorine atom, a bromine atom or an iodine atom.

[0060] Likewise, of the compounds represented by the formula (1), the compounds in which A_1 is a substituted or unsubstituted anthracen-9,10-diyl group and k is 2 can be produced by dehydro-aromatizing compounds obtained by reacting compounds represented by the formula (8) and the formula (11) with a lithio compound or a Grignard reagent that can be formed by a reaction of *n*-butyl lithium and metallic magnesium and substituted or unsubstituted bianthrone in the presence of an acid (for example, hydriodic acid).

[0061] Compounds A according to the invention are produced, as required, in the form of a solvate with a solvent (for example, an aromatic hydrocarbon solvent such as toluene or the like). Compounds A according to the invention include such solvates, and, of course, include solvent-free substances.

[0062] In the organic electroluminescent element of the invention, of course, solvent-free substances of compounds A according to the invention and also such solvates are available.

[0063] Incidentally, when compounds A according to the invention are used in the organic electroluminescent element, it is advisable to use compounds of which the purity is increased by a purification method such as a recrystallization method, a column chromatography method, a sublimation purification method or a combination of these methods.

[0064] The organic electroluminescent element is usually formed such that at least one luminescent layer containing at least one luminescent component is held between a pair of electrodes. In consideration of performance levels of hole injection, hole transport, electron injection and electron transport of compounds used in the luminescent layer, a hole injection transport layer containing a hole injection transport component and/or an electron injection transport layer containing an electron injection transport component can also be formed as required.

[0065] For example, when a hole injection performance, a hole transport performance and/or an electron injection performance and an electron transport performance of a compound used in the luminescent layer are good, it is possible to provide an element of a type that the luminescent layer serves also as a hole injection transport layer and/or an electron injection transport layer. Of course, it is also possible, as required, to provide an element of a type free from both a hole injection transport layer and an electron injection transport layer (monolayer-type element).

[0066] Further, each of the hole injection transport layer, the electron injection transport layer and the luminescent layer may be a monolayer structure or a multilayer structure.

[0067] With respect to the hole injection transport layer and the electron injection transport layer, each layer can be formed such that a layer having an injection performance and a layer having a transport performance are provided separately.

[0068] In the organic electroluminescent element of the invention, compounds A according to the invention are preferably used as a hole injection transport component, a luminescent component or an electron injection transport component, more preferably as a hole injection transport component or a luminescent component, further preferably as a luminescent component.

[0069] In the organic electroluminescent element of the invention, compounds A according to the invention may be used either singly or in combination.

[0070] The structure of the organic electroluminescent element of the invention is not particularly limited. Examples thereof can include (A) an anode/hole injection transport layer/luminescent layer/electron injection transport layer/cathode-type element (Fig. 1), (B) an anode/hole injection transport layer/luminescent layer/cathode-type element (Fig. 2), (C) an anode/luminescent layer/electron injection transport layer/cathode-type element (Fig. 3), and (D) an anode/luminescent layer/cathode-type element (Fig. 4). Moreover, (E) an anode/hole injection transport layer/electron injection transport layer/luminescent layer/electron injection transport layer/cathode-type element (Fig. 5) which is an element of a type with a luminescent layer held between electron injection transport layers is also available. With respect to the (D)-type element structure, the element of the type with the luminescent component in the form of one layer held between a pair of electrodes is included. Further, there are, for example, (F) an element of a type in which a combination of a hole injection transport component, a luminescent component and an electron injection transport component in the form of one layer is held between a pair of electrodes (Fig. 6), (G) an element of a type in which a combination of a hole injection transport component and a luminescent component in the form of one layer is held between a pair of electrodes (Fig. 7), and (H) an element of a type in which a combination of a luminescent component and an electron injection transport component in the form of one layer is held between a pair of electrodes (Fig. 8).

[0071] In the organic electroluminescent element of the invention, these element structures are not critical. In each type of the element, a hole injection transport layer, a luminescent layer or an electron injection transport layer can be formed as plural layers. Further, in each type of the element, it is also possible that a combined layer of a hole injection transport component and a luminescent component is formed between a hole injection transport layer and a luminescent layer and/or a combined layer of a luminescent component and an electron injection transport component is formed between a luminescent layer and an electron injection transport layer.

[0072] With respect to the structure of the organic electroluminescent element, the (A)-type element, the (B)-type element, the (C)-type element, the (E)-type element, the (F)-type element, the (G)-type element or the (H)-type element is preferable. The (A)-type element, (B)-type element, the (C)-type element, the (F)-type element or the (H)-type element is more preferable.

[0073] As the organic electroluminescent element of the invention, for example, (A) the anode/hole injection transport layer/luminescent layer/electron injection transport layer/cathode-type element shown in Fig. 1 is described.

[0074] In Fig. 1, 1 is a substrate, 2 an anode, 3 a hole injection transport layer, 4 a luminescent layer, 5 a hole injection transport layer, 6 a cathode and 7 a power supply.

[0075] It is advisable that the electroluminescent element of the invention is supported by the substrate 1. The substrate is not particularly limited. It is advisable that the substrate is transparent or semitransparent. Examples thereof include substrates made of a glass plate, a transparent plastic sheet (for example, a sheet of polyester, polycarbonate, polysulfone, polymethyl methacrylate, polypropylene, polyethylene or the like), a semitransparent plastic sheet, quartz, transparent ceramics and a composite sheet of a combination of these. Further, a luminescent color can be controlled by combining the substrate with, for example, a color filter film, a color conversion film or a dielectric reflecting mirror.

[0076] In the anode 2, it is advisable to use a metal, an alloy or an electroconductive compound having a relatively large work function as an electrode material.

[0077] Examples of the electrode material used in the anode can include gold, platinum, silver, copper, cobalt, nickel,

palladium, vanadium, tungsten, tin oxide, zinc oxide, ITO (indium-tin-oxide), polythiophene and polypyrrole. These electrode materials may be used either singly or in combination.

[0078] The anode can be formed on the substrate by a method such as a deposition method, a sputtering method or the like using these electrode materials. Further, the anode may be a monolayer structure or a multilayer structure.

[0079] A sheet electric resistance of the anode is set at, preferably less than several hundreds of ohms/ \square , preferably 5 to 50 Ω/\square .

[0080] A thickness of the anode varies with the electrode material used. It is set at, generally 5 to 1,000 nm, preferably 10 to 500 nm.

[0081] The hole injection transport layer 3 is a layer having a performance of facilitating injection of holes from the anode and a performance of transporting holes injected.

[0082] The hole injection transport layer can be formed using at least one of compounds A according to the invention and/or other compounds having a hole injection transport performance (for example, phthalocyanine derivatives, triarylmethane derivatives, triarylamine derivatives, oxazole derivatives, hydrazone derivatives, stilbene derivatives, pyrazoline derivatives, polysilane derivatives, polyphenylenevinylene and its derivatives, polythiophene and its derivatives, and poly-N-vinylcarbazole derivatives).

[0083] By the way, the compounds having the hole injection transport performance may be used either singly or in combination.

[0084] Preferable examples of other compounds having the hole injection transport performance which are used in the invention include triarylamine derivatives (for example, 4,4'-bis[N-phenyl-N-(4"-methylphenyl)amino]biphenyl, 4,4'-bis[N-phenyl-N-(3"-methylphenyl)amino]biphenyl, 4,4'-bis[N-phenyl-N-(3"-methoxyphenyl)amino]biphenyl, 4,4'-bis[N-phenyl-N-(1"-naphthyl)amino]biphenyl, 3,3'-dimethyl-4,4'-bis[N-phenyl-N-(3"-methylphenyl)amino]biphenyl, 1,1-bis[4'-[N,N-di(4"-methylphenyl)amino]phenyl]cyclohexane, 9,10-bis[N-(4'-methylphenyl)-N-(4"-n-butylphenyl)amino]phenanthrene, 3,8-bis(N,N-diphenylamino)-6-phenylphenanthridine, 4-methyl-N,N-bis[4',4"-bis[N',N'-di(4-methylphenyl)amino]biphenyl-4-yl]aniline, N,N'-bis[4-(diphenylamino)phenyl]-N,N'-diphenyl-1,3-diaminobenzene, N,N'-bis[4-(diphenylamino)phenyl]-N,N'-diphenyl-1,4-diaminobenzene, 5,5'-bis[4-(bis[4-methylphenyl]amino)phenyl-2,2':5',2"-terthiophene, 1,3,5-tris(diphenylamino)benzene, 4,4',4"-tris(N-carbazolyl)triphenylamine, 4,4',4"-tris[N-(3"-methylphenyl)-N-phenylamino]triphenylamine, 4,4',4"-tris[N,N-bis(4"-tert-butylbiphenyl-4"-yl)amino]triphenylamine, 1,3,5-tris[N-(4'-diphenylaminophenyl)-N-phenylamino]benzene), polythiophene and its derivatives, and poly-N-vinylcarbazole derivatives.

[0085] When compounds A according to the invention and the other compounds having the hole injection transport performance are used in combination, the ratio of compounds A according to the invention that are occupied in the hole injection transport layer is preferably adjusted to between 0.1 and 40 % by weight.

[0086] The luminescent layer 4 is a layer containing a compound having a hole and electron injection performance, their transport performance and a performance of generating excitons by recombination of holes and electrons.

[0087] The luminescent layer can be formed using at least one of compounds A according to the invention and/or other compounds having a luminescent performance (for example, acridone derivatives, quinacridone derivatives, diketo pyrrolopyrrole derivatives, polycyclic aromatic compounds [for example, rubrene, anthracene, tetracene, pyrene, perylene, chrysene, decacyclene, coronene, tetraphenylcyclopentadiene, pentaphenylcyclohexadiene, 9,10-diphenylanthracene, 9,10-bis(phenylethynyl)anthracene, 1,4-bis(9"-ethynylantraceny)benzene, 4,4'-bis(9"-ethynylantraceny)biphenyl], triarylamine derivatives [for example, the foregoing compounds can be mentioned as compounds having the hole injection transport performance], organic metal complexes [for example, tris(8-quinolinolato)aluminum, bis(10-benzo[h]quinolinolato)beryllium, 2-(2'-hydroxyphenyl)benzoxazole zinc salt, 2-(2'-hydroxyphenyl)benzothiazole zinc salt, 4-hydroxyacridine zinc salt, 3-hydroxyflavone zinc salt, 5-hydroxyflavone beryllium salt, and 5-hydroxyflavone aluminum salt], stilbene derivatives [for example, 1,1,4,4-tetraphenyl-1,3-butadiene, 4,4'-bis(2,2-diphenylvinyl)biphenyl, 4,4'-bis[(1,1,2-triphenyl)ethenyl]biphenyl], coumalin derivatives [for example, coumalin 1, coumalin 6, coumalin 7, coumalin 30, coumalin 106, coumalin 138, coumalin 151, coumalin 152, coumalin 153, coumalin 307, coumalin 311, coumalin 314, coumalin 334, coumalin 338, coumalin 343 and coumalin 500], pyran derivatives [for example, DCM1 and DCM 2], oxazone derivatives [for example, Nile Red], benzothiazole derivatives, benzoxazole derivatives, benzimidazole derivatives, pyrazine derivatives, cinnamate ester derivatives, poly-N-vinylcarbazole and its derivatives, polythiophene and its derivatives, polyphenylene and its derivatives, polyfluorene and its derivatives, polyphenylenevinylene and its derivatives, polybiphenylenevinylene and its derivatives, polyterphenylenevinylene and its derivatives, polynaphthylenevinylene and its derivatives, and polythienylenevinylene and its derivatives].

[0088] In the organic electroluminescent element of the invention, it is advisable that the luminescent layer contains compounds A according to the invention.

[0089] In the organic electroluminescent element of the invention, compounds A according to the invention may be used in the luminescent layer either singly or in combination with other compounds having a luminescent performance.

[0090] When compounds A according to the invention and the other compounds having the luminescent performance are used in combination, the ratio of compounds A according to the invention which are occupied in the luminescent

layer is adjusted to, preferably 0.001 to 99.999 % by weight, more preferably 0.01 to 99.99 % by weight, further preferably 0.1 to 99.9 % by weight.

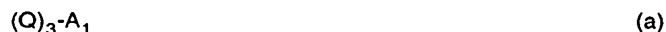
[0091] The other compounds having the luminescent performance which are used in the invention are preferably luminescent organic metal complexes. As described in, for example, J. Appl. Phys., 65, 3610 (1989) and Japanese Patent Laid-Open No. 214,332/1993, the luminescent layer can be formed of a host compound and a guest compound (dopant).

[0092] The luminescent layer can be formed using compounds A according to the invention as a host compound. Further, the luminescent layer can be formed using compounds A as a guest compound.

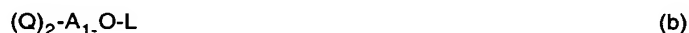
[0093] When the luminescent layer is formed using compounds A according to the invention as a guest compound, for example, the foregoing other compounds having the luminescent performance can be mentioned as the host compound. Preferable are the luminescent metal complexes or the foregoing triarylamine derivatives.

[0094] In this case, compounds A according to the invention are used in amounts of, preferably 0.001 to 40 % by weight, more preferably 0.01 to 30 % by weight, especially preferably 0.1 to 20 % by weight relative to the luminescent organic metal complexes or the triarylamine derivatives.

[0095] The luminescent organic metal complexes used in combination with compounds A according to the invention are not particularly limited. Luminescent organic aluminum complexes are preferable, and luminescent organic aluminum complexes having a substituted or unsubstituted 8-quinolinolato ligand are more preferable. Preferable examples of the luminescent organic metal complexes can include luminescent organic aluminum complexes represented by the formula (a) to the formula (c).



wherein Q represents a substituted or unsubstituted 8-quinolinolato ligand



wherein Q represents a substituted 8-quinolinolato ligand, O-L represents a phenolato ligand, and L represents a hydrocarbon group having 6 to 24 carbon atoms and containing a phenyl moiety)



wherein Q represents a substituted 8-quinolinolato ligand.

[0096] Specific examples of the luminescent organic metal complexes can include tris(8-quinolinolato)aluminum, tris(4-methyl-8-quinolinolato)aluminum,

tris(5-methyl-8-quinolinolato)aluminum,

tris(3,4-dimethyl-8-quinolinolato)aluminum,

tris(4,5-dimethyl-8-quinolinolato)aluminum,

tris(4,6-dimethyl-8-quinolinolato)aluminum,

bis(2-methyl-8-quinolinolato)(phenolato)aluminum,

bis(2-methyl-8-quinolinolato)(2-methylphenolato)aluminum,

bis(2-methyl-8-quinolinolato)(3-methylphenolato)aluminum,

bis(2-methyl-8-quinolinolato)(4-methylphenolato)aluminum,

bis(2-methyl-8-quinolinolato)(2-phenylphenolato)aluminum,

bis(2-methyl-8-quinolinolato)(3-phenylphenolato)aluminum,

bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum,

bis(2-methyl-8-quinolinolato)(2,3-dimethylphenolato)aluminum,

bis(2-methyl-8-quinolinolato)(2,6-dimethylphenolato)aluminum,

bis(2-methyl-8-quinolinolato)(3,4-dimethylphenolato)aluminum,

bis(2-methyl-8-quinolinolato)(3,5-dimethylphenolato)aluminum,

bis(2-methyl-8-quinolinolato)(3,5-di-tert-butylphenolato)aluminum,

bis(2-methyl-8-quinolinolato)(2,6-diphenylphenolato)aluminum,

bis(2-methyl-8-quinolinolato)(2,4,6-triphenylphenolato)aluminum,

bis(2-methyl-8-quinolinolato)(2,4,6-trimethylphenolato)aluminum,

bis(2-methyl-8-quinolinolato)(2,4,5,6-tetramethylphenolato)aluminum,

bis(2-methyl-8-quinolinolato)(1-naphtholato)aluminum,
 bis(2-methyl-8-quinolinolato)(2-naphtholato)aluminum,
 bis(2,4-dimethyl-8-quinolinolato)(2-phenylphenolato)aluminum,
 bis(2,4-dimethyl-8-quinolinolato)(3-phenylphenolato)aluminum,
 5 bis(2,4-dimethyl-8-quinolinolato)(4-phenylphenolato)aluminum,
 bis(2,4-dimethyl-8-quinolinolato)(3,5-dimethylphenylphenolato)aluminum,
 bis(2,4-dimethyl-8-quinolinolato)(3,5-di-tert-butylphenylphenolato)aluminum,
 bis(2-methyl-8-quinolinolato)aluminum- μ -oxo-bis(2-methyl-8-quinolinolato)aluminum,
 bis(2,4-dimethyl-8-quinolinolato)aluminum- μ -oxo-bis(2,4-dimethyl-8-quinolinolato)aluminum,
 10 bis(2-methyl-4-ethyl-8-quinolinolato)aluminum- μ -oxo-bis(2-methyl-4-ethyl-8-quinolinolato)aluminum,
 bis(2-methyl-4-methoxy-8-quinolinolato)aluminum- μ -oxo-bis(2-methyl-4-methoxy-8-quinolinolato)aluminum,
 bis(2-methyl-5-cyano-8-quinolinolato)aluminum- μ -oxo-bis(2-methyl-5-cyano-8-quinolinolato)aluminum, and bis
 (2-methyl-5-trifluoromethyl-8-quinolinolato)aluminum- μ -oxo-bis(2-methyl-5-trifluoromethyl-8-quinolinolato)aluminum.
 Of course, the luminescent organic metal complexes may be used either singly or in combination.

15 **[0097]** The electron injection transport layer 5 is a layer containing a compound having a performance of facilitating injection of electrons from a cathode and a performance of transporting electrons injected.

[0098] The electron injection transport layer can be formed using at least one of compounds A according to the invention and/or other compounds having an electron injection transport performance (for example, organic metal complexes [for example, tris(8-quinolinolato)aluminum, bis(10-benzo[h]quinolinolato)beryllium, 5-hydroxyflavone beryllium salt, and 5-hydroxyflavone aluminum salt], oxadiazole derivatives [for example, 1,3-bis[5'-(4'-tert-butylphenyl)-1',3',4'-oxadiazol-2'-yl]benzene], triazole derivatives [for example, 3-(4'-tert-butylphenyl)-4-phenyl-5-(4"-phenylphenyl)-1,2,4-triazole], triazine derivatives, perylene derivatives, quinoline derivatives, quinoxaline derivatives, diphenylquinone derivatives, nitro-substituted fluorenone derivatives, and thiopyran dioxide derivatives).

20 **[0099]** Incidentally, the compounds having the electron injection transport performance may be used either singly or in combination.

25 **[0100]** When compounds A according to the invention and the other compounds having the electron injection transport performance are used in combination, the ratio of compounds A according to the invention which are occupied in the electron injection transport layer is adjusted to, preferably 0.1 to 40 % by weight. In the invention, it is advisable that the electron injection transport layer is formed using compounds A according to the invention and the organic metal complexes [for example, the compounds represented by the formula (a) to the formula (c)] in combination.

30 **[0101]** With respect to the cathode 6, a metal, an alloy or an electroconductive compound having a relatively small work function is used as the electrode material.

Examples of the electrode material used in the cathode can include lithium, a lithium-indium alloy, sodium, a sodium-potassium alloy, calcium, magnesium, a magnesium-silver alloy, a magnesium-indium alloy, indium, ruthenium, titanium, manganese, yttrium, aluminum, an aluminum-lithium alloy, an aluminum-calcium alloy, an aluminum-magnesium alloy, and a graphite thin film. These electrode materials may be used either singly or in combination.

35 **[0102]** The cathode can be formed on the electron injection transport layer by a method such as a deposition method, a sputtering method, an ionization deposition method, an ion plating method, a cluster ion beam method or the like.

[0103] Further, the cathode may be a monolayer structure or a multilayer structure.

40 **[0104]** Incidentally, it is advisable that a sheet electric resistance of the cathode is set at less than several hundreds of ohms/ \square .

[0105] A thickness of the cathode varies depending on the electrode material used. It is set at, generally 5 to 1,000 nm, more preferably 10 to 500 nm.

45 **[0106]** By the way, for taking out emitted light of the organic electroluminescent element at good efficiency, it is preferable that at least one electrode of the anode and the cathode is transparent or semitransparent. In general, it is more preferable to set the material of the anode and its thickness such that a transmission of emitted light reaches more than 70 %.

[0107] Further, in the organic electroluminescent element of the invention, at least one layer thereof may contain a singlet oxygen quencher. The singlet oxygen quencher is not particularly limited. Examples thereof include rubrene, a nickel complex, and diphenylisobenzofuran. Rubrene is especially preferable.

50 **[0108]** The layer containing the singlet oxygen quencher is not particularly limited. It is preferably a luminescent layer or a hole injection transport layer, more preferably a hole injection transport layer. By the way, for example, when the hole injection transport layer contains the singlet quencher, it may uniformly be contained in the hole injection transport layer or in the vicinity of a layer adjacent the hole injection transport layer (for example, the luminescent layer or the electron injection transport layer having the luminescent performance).

55 **[0109]** The content of the singlet oxygen quencher is 0.01 to 50 % by weight, preferably 0.05 to 30 % by weight, more preferably 0.1 to 20 % by weight of the total amount of the layer (for example, the hole injection transport layer) containing the same.

[0110] A method for forming the hole injection transport layer, the luminescent layer or the electron injection transport layer is not particularly limited. It can be provided by forming a thin film by, for example, a vacuum deposition method, an ionization deposition method or a solution coating method (for example, a spin coating method, a casting method, a dip coating method, a bar coating method, a roll coating method, a Langmuir-Blodgett method or an ink jet method).

[0111] When each layer is formed by a vacuum deposition method, the conditions for the vacuum deposition are not particularly limited. It is advisable to perform the same under vacuum of 1×10^{-4} Pa at a boat temperature (deposition source temperature) of 50 to 600°C, a substrate temperature of -50 to 300°C and a deposition rate of 0.005 to 50 nm/sec.

[0112] In this case, the organic electroluminescent element having better characteristics can be produced by continuously forming each of the hole injection transport layer, the luminescent layer, the electron injection transport layer and the like in vacuo.

[0113] When each of the hole injection transport layer, the luminescent layer, the electron injection transport layer and the like is formed by the vacuum deposition method using plural compounds, it is advisable to conduct co-deposition by separately controlling temperatures of boats filled with the compounds.

[0114] When each layer is formed by a solution coating method, the component constituting each layer or the component and a binder resin are dissolved or dispersed in a solvent to form a coating solution.

[0115] Examples of the binder resin that can be used in each of the hole injection transport layer, the luminescent layer and the electron injection transport layer include polymer compounds such as poly-N-vinylcarbazole, polyarylate, polystyrene, polyester, polysiloxane, polymethyl acrylate, polymethyl methacrylate, polyether, polycarbonate, polyamide, polyimide, polyamide-imide, poly-p-xylylene, polyethylene, polyphenylene oxide, polyether sulfone, polyaniline and its derivatives, polythiophene and its derivatives, polyphenylenevinylene and its derivatives, polyfluorene and its derivatives, and polythienylenevinylene and its derivatives. The binder resins may be used either singly or in combination.

[0116] When each layer is formed by a solution coating method, the component constituting each layer or the component and the binder resin are dissolved or dispersed in an appropriate organic solvent (hydrocarbon solvents such as hexane, octane, decane, toluene, xylene, ethylbenzene, 1-methylnaphthalene and the like, ketone solvents such as acetone, methyl ethyl ketone, methyl isobutyl ketone, cyclohexanone and the like, halogenated hydrocarbon solvents such as dichloromethane, chloroform, tetrachloromethane, dichloroethane, trichloroethane, tetrachloroethane, chlorobenzene, dichlorobenzene, chlorotoluene and the like, ester solvents such as ethyl acetate, butyl acetate, amyl acetate and the like, alcohol solvents such as methanol, propanol, butanol, pentanol, hexanol, cyclohexanol, methyl cellosolve, ethyl cellosolve, ethylene glycol and the like, ether solvents such as dibutyl ether, tetrahydrofuran, dioxane, anisole and the like, and polar solvents such as N,N-dimethylformamide, N,N-dimethylacetamide, 1-methyl-2-pyrrolidone, 1-methyl-2-imidazolidinone, dimethyl sulfoxide and the like) and/or water to form a coating solution, and a thin film can be formed by various coating methods.

[0117] Incidentally, the dispersion method is not particularly limited. The dispersion can be conducted in the form of fine particles using a ball mill, a sand mill, a paint shaker, an attritor, a homogenizer or the like. The concentration of the coating solution is not particularly limited. It can be set at a range suited for providing a desired thickness according to a coating method to be performed. The concentration of the solution is generally 0.1 to 50 % by weight, preferably 1 to 30 % by weight.

[0118] By the way, in case of using the binder resin, its use amount is not particularly limited. It is set at, generally 5 to 99.9 % by weight, preferably 10 to 99.9 % by weight, more preferably 15 to 90 % by weight based on the component constituting each layer (based on the total amount of each component when forming a monolayer-type element).

[0119] A film thickness of the hole injection transport layer, the luminescent layer or the electron injection transport layer is not particularly limited. It is generally advisable to set the film thickness at 5 nm to 5 μ m.

[0120] Incidentally, for preventing contact of the formed element with oxygen or moisture, it is possible to form a protecting layer (blocking layer) or to protect the element by sealing the same in an inactive substance such as paraffin, liquid paraffin, silicon oil, fluorocarbon oil, zeolite-containing fluorocarbon oil or the like.

[0121] Examples of the material used in the protecting layer can include organic polymer materials (for example, a fluorinated resin, an epoxy resin, a silicone resin, an epoxy silicone resin, polystyrene, polyester, polycarbonate, polyamide, polyimide, polyamide-imide, poly-p-xylylene, polyethylene, and polyphenylene oxide), inorganic materials (for example, a diamond thin film, an amorphous silica, an electric insulating glass, a metal oxide, a metal nitride, a metal carbide, and a metal sulfide), and thermosetting resins. The materials used in the protecting layer may be used either singly or in combination. The protecting layer may be a monolayer structure or a multilayer structure.

[0122] Further, for example, a metal oxide film (for example, aluminum oxide film) or a metal fluoride film can also be formed on the electrode as a protecting layer.

[0123] Still further, for example, an interfacial layer (intermediate layer) made of, for example, an organic phosphorus compound, polysilane, organic amine derivatives or phthalocyanine derivatives can be formed on, for example, the surface of the anode.

[0124] Furthermore, the electrode, for example, the anode or its surface can be used by being treated with, for example, an acid, ammonia/hydrogen peroxide or plasma.

[0125] The organic electroluminescent element of the invention is generally used as a DC driving-type element, and can also be used as an AC driving-type element. Further, the organic electroluminescent element of the invention may be a passive driving type such as a segment type, a single matrix driving type or the like, or an active driving type such as a TFT (thin film transistor) type, an MIM (metal-insulator-metal) type or the like. A driving voltage is generally 2 to 30 V.

[0126] The organic electroluminescent element of the invention can be used in, for example, panel-type light sources, various luminescent elements, various display devices, various marks, various sensors and the like.

Examples

[0127] The invention is illustrated more specifically below by referring to Production Examples and Examples. Of course, the invention is not limited to these Examples.

Production Example 1

Production of compound Illustrative Compound No. A-5

[0128] 3.33 g of 9-bromo-10-phenylanthracene, 2.38 g of 9,9-dimethylfluoren-2-ylboric acid, 2.12 g of sodium carbonate and 0.35 g of tetrakis(triphenylphosphine)palladium were heat-refluxed in toluene (100 ml) and water (50 ml) for 5 hours. After toluene was distilled off from the reaction mixture, a solid matter precipitated was filtered. This solid matter was treated by silica gel column chromatography (eluent: toluene). After toluene was distilled off under reduced pressure, the residue was recrystallized from a mixed solvent of toluene and acetone to obtain 2.18 g of compound Illustrative Compound A-5 as a yellow crystal.

Mass analysis: $m/z = 446$

Elemental analysis: (as $C_{35}H_{26}$)		
Calculated (%)	C 94.13	H 5.87
Found(%)	94.20	5.80

Melting point 250°C or more

[0129] By the way, this compound was sublimated under conditions of 300°C and 1×10^{-4} Pa.

Absorption maximum (in toluene) 390 nm

Production Examples 2 to 62

[0130] Various compounds were produced according to the process described in Production Example 1 except that in Production Example 1, various halogenated compounds were used instead of using 9-bromo-10-phenylanthracene and various boric acid derivatives instead of using 9,9-dimethylfluoren-2-ylboric acid.

[0131] Halogenated compounds and boric acid derivatives used and compounds produced by Illustrative Compound Numbers were shown in Tables 1 to 5.

[0132] Further, absorption maximum (NM) in toluene was also shown.

[0133] Incidentally, the compounds produced were yellow to orangish yellow crystals, and the melting point of these compounds was 250°C or more.

Table 1

Production Example	Halogenated compounds	Boric acid derivatives	Illustrative Compound No.	Absorption maximum (nm)
2	9-bromo-10-(4'-methylphenyl)anthracene	9,9-dimethylfluoren-2-ylboric acid	A-6	390
3	9-bromo-10-(4'-ethylphenyl)anthracene	9,9-dimethylfluoren-2-ylboric acid	A-8	390
4	9-bromo-10-(4'-isopropylphenyl)anthracene	9,9-dimethylfluoren-2-ylboric acid	A-9	392
5	9-bromo-10-(4'-tert-butylphenyl)anthracene	9,9-dimethylfluoren-2-ylboric acid	A-11	390
6	9-bromo-10-(4'-(N,N-diphenylamino)phenyl)anthracene	7-(N,N-diphenylamino)-9,9-dimethylfluoren-2-ylboric acid	A-13	392
7	9-bromo-10-(4'-(N-phenyl-N-(1"-naphthyl)amino)phenyl)anthracene	9,9-dimethylfluoren-2-ylboric acid	A-14	392
8	9-bromo-10-(4'-ethylphenyl)anthracene	9,9-diethylfluoren-2-ylboric acid	A-17	390
9	9-bromo-10-(1"-naphthyl)anthracene	9,9-dimethylfluoren-2-ylboric acid	A-19	395
10	9-bromo-10-(4'-phenylphenyl)anthracene	9,9-dimethylfluoren-2-ylboric acid	A-21	402
11	9-bromo-10-(2'-phenylphenyl)anthracene	9,9-dimethylfluoren-2-ylboric acid	A-23	397
12	9-bromo-10-(4'-(4"-isopropylphenyl)phenyl)anthracene	9,9-methylfluoren-2-ylboric acid	A-25	401
13	2,3-dimethyl-9-bromo-10-phenylanthracene	9,9-dimethylfluoren-2-ylboric acid	A-26	390
14	2,6-dimethyl-9-bromo-10-phenylanthracene	9,9-dimethylfluoren-2-ylboric acid	A-35	390
15	9-bromo-10-phenylanthracene	9,9-diphenylfluoren-2-ylboric acid	A-38	398
16	9-bromo-10-(4'-methoxyphenyl)anthracene	9,9-dimethylfluoren-2-ylboric acid	A-40	391
17	9-bromo-10-(4'-n-propyloxyphenyl)anthracene	9,9-dimethylfluoren-2-ylboric acid	A-43	392

Table 2

Production Example	Halogenated compounds	Boric acid derivatives	Illustrative Compound No.	Absorption maximum (nm)
18	9-bromo-10-(4'-tert-butyl-oxiphenyl)anthracene	9,9-dimethylfluoren-2-ylboric acid	A-45	393
19	9-bromo-10-(4'-fluorophenyl)anthracene	9,9-dimethylfluoren-2-ylboric acid	A-47	393
20	9-bromo-10-(4'-n-propyl-oxiphenyl)anthracene	9,9-n-propylfluoren-2-ylboric acid	A-53	395
21	9-bromo-10-(6'-methoxy-2'-naphthyl)anthracene	9,9-dimethylfluoren-2-ylboric acid	A-55	398
22	9-bromo-10-[4'-(4"-n-hexyloxyphenyl)phenyl]anthracene	9,9-dimethylfluoren-2-ylboric acid	A-58	400
23	9-bromo-10-(9',9'-dimethylfluoren-2'-yl)anthracene	9,9-di-n-pentylfluoren-2-ylboric acid	C-8	398
24	9-bromo-10-(9'-methyl-8'-phenylfluoren-2'-yl)anthracene	9,9-dimethylfluoren-2-ylboric acid	C-12	404
25	9-bromo-10-(9',9'-diphenylfluoren-2'-yl)anthracene	9,9-dimethylfluoren-2-ylboric acid	C-14	407
26	9-bromo-10-(9',9'-diphenylfluoren-2'-yl)anthracene	9,9-di-n-hexylfluoren-2-ylboric acid	C-20	408
27	9-bromo-10-phenylanthracene	7-(9',9'-dimethylfluoren-2'-yl)-9,9-dimethylfluoren-2-ylboric acid	D-1	405
28	9-bromo-10-(4'-n-hexylphenyl)anthracene	7-(9',9'-dimethylfluoren-2'-yl)-9,9-dimethylfluoren-2-ylboric acid	D-8	407
29	9-bromo-10-(4'-phenylphenyl)anthracene	7-(9',9'-dimethylfluoren-2'-yl)-9,9-dimethylfluoren-2-ylboric acid	D-16	408
30	9-bromo-10-(4'-methoxyphenyl)anthracene	7-(9',9'-dimethylfluoren-2'-yl)-9,9-dimethylfluoren-2-ylboric acid	D-31	398
31	9-bromo-10-phenylanthracene	10-(9',9'-dimethylfluoren-2'-yl)anthracen-9-ylboric acid	E-1	416
32	9-bromo-10-[4'-(N,N-diphenylamino)phenyl]anthracene	10-(9',9'-dimethylfluoren-2'-yl)anthracen-9-ylboric acid	E-7	414

Table 3

Production Example	Halogenated compounds	Boric acid derivatives	Illustrative Compound No.	Absorption maximum (nm)
33	9-bromo-10-(4'-phenylphenyl)anthracene	10-(9',9'-dimethylfluoren-2'-yl)anthracen-9-yl boric acid	E-16	418
34	9-bromo-10-(2'-phenylphenyl)anthracene	10-(9',9'-dimethylfluoren-2'-yl)anthracen-9-yl boric acid	E-18	414
35	9-bromo-10-(4'-methoxyphenyl)anthracene	10-(9',9'-dimethylfluoren-2'-yl)anthracen-9-yl boric acid	E-21	410
36	9-bromo-10-(6'-methoxy-2'-naphthyl)anthracene	10-(9',9'-dimethylfluoren-2'-yl)anthracen-9-yl boric acid	E-35	420
37	9-(7'-iodo-9',9'-dimethylfluoren-2'-yl)-10-(4'-ethylphenyl)anthracene	10-(9',9'-dimethylfluoren-2'-yl)anthracen-9-yl boric acid	F-3	410
38	9-(7'-iodo-9',9'-dimethylfluoren-2'-yl)-10-(3'-phenylphenyl)anthracene	10-(9',9'-dimethylfluoren-2'-yl)anthracen-9-yl boric acid	F-17	412
39	9-(7'-iodo-9',9'-dimethylfluoren-2'-yl)-10-[4'-(N,N-diphenylamino)phenyl]anthracene	10-(9',9'-dimethylfluoren-2'-yl)anthracen-9-yl boric acid	F-24	408
40	2-iodo-7-(9',9'-dimethylfluoren-2'-yl)-9,9-dimethylfluorene	10-(9',9'-dimethylfluoren-2'-yl)anthracen-9-yl boric acid	G-1	414
41	2-iodo-7-(9',9'-dimethylfluoren-2'-yl)-9,9-dimethylfluorene	10-[7'-N,N-di(1"-naphthyl)amino-9',9'-dimethylfluoren-2'-yl]anthracen-9-ylboric acid	G-13	414
42	2-iodo-7-(9',9'-dimethylfluoren-2'-yl)-9,9-dimethylfluorene	10-(9',9'-diphenylfluoren-2'-yl)anthracen-9-yl boric acid	G-25	418
43	9-bromo-10-(9',9'-di-n-butylfluoren-2'-yl)anthracene	10-(9',9'-dimethylfluoren-2'-yl)anthracen-9-yl boric acid	H-7	420
44	10-bromo-10'-(4"-ethylphenyl)-9,9'-bianthryl	7-[10'-(4"-ethylphenyl)anthracen-9'-yl]-9,9-dimethylfluoren-2'-ylboric acid	J-3	422
45	10-bromo-10'-(4"-ethoxyphenyl)-9,9'-bianthryl	7-[10'-(4"-ethoxyphenyl)anthracen-9'-yl]-9,9-dimethylfluoren-2'-ylboric acid	J-22	422

Table 4

Production Example	Halogenated compounds	Boric acid derivatives	Illustrative Compound No.	Absorption maximum (nm)
46	10-bromo-10'-(4"-ethylphenyl)-9,9'-bianthryl	7-(9',9'-dimethylfluoren-2'-yl)-9,9-dimethylfluoren-2-ylboric acid	K-3	416
47	10-bromo-10'-(1"-naphthyl)-9,9'-bianthryl	7-(9',9'-dimethylfluoren-2'-yl)-9,9-dimethylfluoren-2-ylboric acid	K-14	418
48	10-bromo-10'-(4"-phenylphenyl)-9,9'-bianthryl	7-(9',9'-dimethylfluoren-2'-yl)-9,9-dimethylfluoren-2-ylboric acid	K-16	416
49	9-(7'-iodo-9',9'-dimethylfluoren-2'-yl)-10-(8",9"-dimethylfluoren-2"-yl)anthracene	7-(10'-phenylanthracen-9'-yl)-9,9-dimethylfluoren-2-ylboric acid	L-1	415
50	9-(7'-iodo-9',9'-dimethylfluoren-2'-yl)-10-(9",9"-dimethylfluoren-2"-yl)anthracene	7-[10'-(2"-phenylphenyl)anthracen-9'-yl]-9,9-dimethylfluoren-2-ylboric acid	L-19	413
51	9-(7'-iodo-9',9'-dimethylfluoren-2'-yl)-10-(9",9"-dimethylfluoren-2"-yl)anthracene	7-[10'-(4"-ethoxyphenyl)anthracen-9'-yl]-9,9-dimethylfluoren-2-ylboric acid	L-32	413
52	10-bromo-10'-(9",9"-dimethylfluoren-2"-yl)-9,9'-bianthryl	7-(9',9'-dimethylfluoren-2'-yl)-9,9-dimethylfluoren-2-ylboric acid	N-1	417
53	10-bromo-10'-(9",9"-diphenylfluoren-2"-yl)-9,9'-bianthryl	7-(9',9'-diphenylfluoren-2'-yl)-9,9-diphenylfluoren-2-ylboric acid	N-24	420
54	10-bromo-10'-(7"-N,N-diphenylamino-9",9"-dimethylfluoren-2"-yl)-9,9'-bianthryl	7-[10'-(4"-ethylphenyl)anthracen-9'-yl]-9,9-dimethylfluoren-2-ylboric acid	O-3	422
55	10-bromo-10'-(9",9"-dimethylfluoren-2"-yl)-9,9'-bianthryl	7-[10'-(2"-naphthyl)anthracen-9'-yl]-9,9-dimethylfluoren-2-ylboric acid	O-15	424
56	10-bromo-10'-(9",9"-dimethylfluoren-2"-yl)-9,9'-bianthryl	7-[10'-(4"-methoxyphenyl)anthracen-9'-yl]-9,9-dimethylfluoren-2-ylboric acid	O-21	412
57	10-phenyl-10'-(7"-iodo-9",9"-dimethylfluoren-2"-yl)-9,9'-bianthryl	7-(10'-phenylanthracen-9'-yl)-9,9-dimethylfluoren-2-ylboric acid	P-1	424

Table 5

Production Example	Halogenated compounds	Boric acid derivatives	Illustrative Compound No.	Absorption maximum (nm)
58	10-(4'-phenylphenyl)-10'-(7"-iodo-9",9"-dimethylfluoren-2"-yl)-9,9'-bianthryl	7-[10'-(4"-phenylphenyl)anthracen-9'-yl]-9,9-dimethylfluoren-2-ylboric acid	P-16	426
59	10-(4'-methoxyphenyl)-10'-(7"-iodo-9",9"-dimethylfluoren-2"-yl)-9,9'-bianthryl	7-[10'-(4"-methoxyphenyl)anthracen-9'-yl]-9,9-dimethylfluoren-2-ylboric acid	P-31	426
60	10-(9,9'-dimethylfluoren-2'-yl)-10'-(7"-iodo-9",9"-dimethylfluoren-2"-yl)-9,9'-bianthryl	7-(10'-phenylanthracen-9'-yl)-9,9-dimethylfluoren-2-ylboric acid	Q-1	426
61	10-(9,9'-dimethylfluoren-2'-yl)-10'-(7"-iodo-9",9"-dimethylfluoren-2"-yl)-9,9'-bianthryl	7-[10'-(4"-n-butylphenyl)anthracen-9'-yl]-9,9-dimethylfluoren-2-ylboric acid	Q-6	426
62	10-(9,9'-dimethylfluoren-2'-yl)-10'-(7"-iodo-9",9"-dimethylfluoren-2"-yl)-9,9'-bianthryl	7-[10'-(4"-methoxyphenyl)anthracen-9'-yl]-9,9-dimethylfluoren-2-ylboric acid	Q-31	424

Production Example 63

Production of compound Illustrative Compound No. B-1

[0134] 10-Phenylanthracen-9-ylboric acid (5.96 g), 4.46 g of 2,7-diiodo-9,9-dimethylfluorene, 4.24 g of sodium carbonate and 0.70 g of tetrakis(triphenylphosphine)palladium were heat-refluxed in toluene (100 ml) and water (50 ml) for 5 hours. After toluene was distilled off from the reaction mixture, a solid matter precipitated was filtered. This solid matter was treated by silica gel column chromatography (eluent: toluene). After toluene was distilled off under reduced pressure, the residue was recrystallized from a mixed solvent of toluene and acetone to obtain 4.88 g of compound Illustrative Compound No. B-1 as a yellow crystal.

Mass analysis: $m/z = 698$

Elemental analysis: (as $C_{55}H_{38}$)		
Calculated (%)	C 94.52	H 5.48
Found (%)	94.56	5.44

Melting point 250°C or more

[0135] By the way, this compound was sublimated under conditions of 300°C and 1×10^{-4} Pa.

Absorption maximum (in toluene) 420 nm

Production Examples 64 to 99

[0136] Various compounds were produced according to the process described in Production Example 63 except that in Example 63, various boric acid derivatives were used instead of using 10-phenylanthracen-9-ylboric acid and various dihalogeno compounds instead of using 2,7-diiodo-9,9-dimethylfluorene.

[0137] Boric acid derivatives and dihalogeno compounds used and compounds produced by Illustrative Compound Numbers were shown in Tables 6 to 8.

[0138] Further, absorption maximum (NM) in toluene was also shown. By the way, the compounds produced were yellow to orangish yellow crystals, and the melting point of these compounds was 250°C or more.

Table 6

Production Example	Boric acid derivatives	Dihalogeno compounds	Illustrative Compound No.	Absorption maximum (nm)
64	10-(4'-methylphenyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-2	420
65	10-(2'-pyridyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-3	416
66	10-(4'-ethylphenyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-6	422
67	10-(4'-isopropylphenyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-9	422
68	10-(4'-[N,N-di(4"-methylphenyl)amino]phenyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-12	420
69	10-(4'-n-decylphenyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-14	422
70	10-(4'-ethylphenyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-diethylfluorene	B-17	420
71	10-(1'-naphthyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-19	425
72	10-(4'-phenylphenyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-21	427
73	10-(2'-phenylphenyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-24	425
74	10-(4'-[N-phenyl-N-(4"-phenylphenyl)amino]phenyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-25	427
75	10-(4'-methoxyphenyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-40	421
76	10-(4'-n-propyloxyphenyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-43	422
77	10-(4'-tert-butyloxyphenyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-45	423
78	10-(4'-fluorophenyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-47	423

Table 7

Production Example	Boric acid derivatives	Dihalogeno compounds	Illustrative Compound No.	Absorption maximum (nm)
79	10-(4'-n-propyloxyphenyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-di-n-propylfluorene	B-53	425
80	10-(6'-methoxy-2'-naphthyl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-55	428
81	10-{4'-(4"-n-hexyloxyphenyl)phenyl}anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	B-58	430
82	9,9-dimethylfluoren-2-ylboric acid	9,10-dibromoanthracene	C-1	398
83	9,9-di-n-butylfluoren-2-ylboric acid	9,10-dibromoanthracene	C-3	400
84	9,9-di-n-hexylfluoren-2-ylboric acid	9,10-dibromoanthracene	C-5	400
85	7-[N,N-di(4'-methylphenyl)amino]-9,9-dimethylfluoren-2-ylboric acid	9,10-dibromoanthracene	C-25	397
86	7-[N-phenyl-N-(1'-naphthyl)amino]-9,9-dimethylfluoren-2-ylboric acid	1,4-dimethyl-9,10-dibromoanthracene	C-28	398
87	9,9-dimethylfluoren-2-ylboric acid	10,10'-dibromo-9,9'-bianthryl	H-1	425
88	10-phenylanthracen-9-ylboric acid	2-iodo-7-(7'-iodo-9',9'-dimethylfluoren-2'-yl)-9,9-dimethylfluorene	I-1	422
89	10-(4'-n-propylphenyl)anthracen-9-ylboric acid	2-iodo-7-(7'-iodo-9',9'-dimethylfluoren-2'-yl)-9,9-dimethylfluorene	I-4	422
90	10-(4'-phenylphenyl)anthracen-9-ylboric acid	2-iodo-7-(7'-iodo-9',9'-dimethylfluoren-2'-yl)-9,9-dimethylfluorene	I-16	424
91	10-{4'-(N,N-dimethylamino)phenyl}anthracen-9-ylboric acid	2-iodo-7-(7'-iodo-9',9'-dimethylfluoren-2'-yl)-9,9-dimethylfluorene	I-31	420
92	10-(9',9'-dimethylfluoren-2'-yl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	M-1	428
93	10-(9',9'-di-n-butylfluoren-2'-yl)anthracen-9-ylboric acid	2,7-diiodo-9,9-di-n-butylfluorene	M-3	430
94	10-(9',9'-di-n-hexylfluoren-2'-yl)anthracen-9-ylboric acid	2,7-diiodo-9,9-di-n-hexylfluorene	M-5	430

Table 8

Production Example	Boric acid derivatives	Dihalogeno compounds	Illustrative Compound No.	Absorption maximum (nm)
95	10-(9',9'-diphenylfluoren-2'-yl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	M-14	437
96	10-{7'-[N,N-di(4"-methylphenyl)amino]-9',9'-dimethylfluoren-2'-yl}anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	M-17	428
97	10-(9',9'-diphenylfluoren-2'-yl)anthracen-9-ylboric acid	2,7-diiodo-9,9-di-n-hexylfluorene	M-20	438
98	10-(9'-methyl-9'-phenylfluoren-2'-yl)anthracen-9-ylboric acid	2,7-diiodo-9,9-dimethylfluorene	M-22	434
99	10-(9',9'-diphenylfluoren-2'-yl)anthracen-9-ylboric acid	2,7-diiodo-9,9-diphenylfluorene	M-24	443

Example 1

[0139] A glass substrate with an ITO transparent electrode (anode) having a thickness of 200 nm was ultrasonically cleaned using a neutral detergent, acetone and ethanol. This substrate was dried using a nitrogen gas, further subjected to UV/ozone cleaning, and then fixed on a substrate holder of a deposition device. Thereafter, a deposition bath was set at reduced pressure of 4×10^{-4} Pa.

[0140] First, 4,4'-bis[N-phenyl-N-(3'-methylphenyl)amino]biphenyl was deposited on the ITO transparent electrode to a thickness of 75 nm at a deposition rate of 0.2 nm/sec to form a hole injection transport layer.

[0141] Then, bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound No. A-5 were co-deposited thereon from different deposition sources to a thickness of 50 nm at a deposition rate of 0.2 nm/sec (weight ratio 100:0.5) to form a luminescent layer.

[0142] Subsequently, tris(8-quinolinolato)aluminum was deposited to a thickness of 50 nm at a deposition rate of 0.2 nm/sec to form an electron injection transport layer.

[0143] Further, magnesium and silver were co-deposited thereon to a thickness of 200 nm at a deposition rate of 0.2 nm/sec (weight ratio 10:1) to form a cathode, and an organic electroluminescent element was produced. By the way, the deposition was conducted while maintaining the state of reduced pressure of the deposition bath.

[0144] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 54 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,420 cd/m² was identified.

Examples 2 to 99

[0145] Organic electroluminescent elements were produced according to the process described in Example 1 except using, instead of using compound Illustrative Compound A-5 in the formation of the luminescent layer in Example 1;

compound Illustrative Compound No. A-6 (Example 2),
 compound Illustrative Compound No. A-8 (Example 3),
 compound Illustrative Compound No. A-9 (Example 4),
 compound Illustrative Compound No. A-11 (Example 5),
 compound Illustrative Compound No. A-13 (Example 6),
 compound Illustrative Compound No. A-14 (Example 7),
 compound Illustrative Compound No. A-17 (Example 8),
 compound Illustrative Compound No. A-19 (Example 9),
 compound Illustrative Compound No. A-21 (Example 10),
 compound Illustrative Compound No. A-23 (Example 11),
 compound Illustrative Compound No. A-25 (Example 12),
 compound Illustrative Compound No. A-26 (Example 13),
 compound Illustrative Compound No. A-35 (Example 14),
 compound Illustrative Compound No. A-38 (Example 15),
 compound Illustrative Compound No. A-40 (Example 16),
 compound Illustrative Compound No. A-43 (Example 17),
 compound Illustrative Compound No. A-45 (Example 18),
 compound Illustrative Compound No. A-47 (Example 19),
 compound Illustrative Compound No. A-53 (Example 20),
 compound Illustrative Compound No. A-55 (Example 21),
 compound Illustrative Compound No. A-58 (Example 22),
 compound Illustrative Compound No. B-1 (Example 23),
 compound Illustrative Compound No. B-2 (Example 24),
 compound Illustrative Compound No. B-3 (Example 25),
 compound Illustrative Compound No. B-6 (Example 26),
 compound Illustrative Compound No. B-9 (Example 27),
 compound Illustrative Compound No. B-12 (Example 28),
 compound Illustrative Compound No. B-14 (Example 29),
 compound Illustrative Compound No. B-17 (Example 30),
 compound Illustrative Compound No. B-19 (Example 31),
 compound Illustrative Compound No. B-21 (Example 32),
 compound Illustrative Compound No. B-24 (Example 33),
 compound Illustrative Compound No. B-25 (Example 34),
 compound Illustrative Compound No. B-40 (Example 35),

compound Illustrative Compound No. B-43 (Example 36),
 compound Illustrative Compound No. B-45 (Example 37),
 compound Illustrative Compound No. B-47 (Example 38),
 compound Illustrative Compound No. B-53 (Example 39),
 5 compound Illustrative Compound No. B-55 (Example 40),
 compound Illustrative Compound No. B-58 (Example 41),
 compound Illustrative Compound No. C-1 (Example 42),
 compound Illustrative Compound No. C-3 (Example 43),
 compound Illustrative Compound No. C-5 (Example 44),
 10 compound Illustrative Compound No. C-8 (Example 45),
 compound Illustrative Compound No. C-12 (Example 46),
 compound Illustrative Compound No. C-14 (Example 47),
 compound Illustrative Compound No. C-20 (Example 48),
 compound Illustrative Compound No. C-25 (Example 49),
 15 compound Illustrative Compound No. C-28 (Example 50),
 compound Illustrative Compound No. D-1 (Example 51),
 compound Illustrative Compound No. D-8 (Example 52),
 compound Illustrative Compound No. D-16 (Example 53),
 compound Illustrative Compound No. D-31 (Example 54),
 20 compound Illustrative Compound No. E-1 (Example 55),
 compound Illustrative Compound No. E-7 (Example 56),
 compound Illustrative Compound No. E-16 (Example 57),
 compound Illustrative Compound No. E-18 (Example 58),
 compound Illustrative Compound No. E-21 (Example 59),
 25 compound Illustrative Compound No. E-35 (Example 60),
 compound Illustrative Compound No. F-3 (Example 61),
 compound Illustrative Compound No. F-17 (Example 62),
 compound Illustrative Compound No. F-24 (Example 63),
 compound Illustrative Compound No. G-1 (Example 64),
 30 compound Illustrative Compound No. G-13 (Example 65),
 compound Illustrative Compound No. G-25 (Example 66),
 compound Illustrative Compound No. H-1 (Example 67),
 compound Illustrative Compound No. H-7 (Example 68),
 compound Illustrative Compound No. I-1 (Example 69),
 35 compound Illustrative Compound No. I-4 (Example 70),
 compound Illustrative Compound No. I-16 (Example 71),
 compound Illustrative Compound No. I-31 (Example 72),
 compound Illustrative Compound No. J-3 (Example 73),
 compound Illustrative Compound No. J-22 (Example 74),
 40 compound Illustrative Compound No. K-3 (Example 75),
 compound Illustrative Compound No. K-14 (Example 76),
 compound Illustrative Compound No. K-16 (Example 77),
 compound Illustrative Compound No. L-1 (Example 78),
 compound Illustrative Compound No. L-19 (Example 79),
 45 compound Illustrative Compound No. L-32 (Example 80),
 compound Illustrative Compound No. M-1 (Example 81),
 compound Illustrative Compound No. M-3 (Example 82),
 compound Illustrative Compound No. M-5 (Example 83),
 compound Illustrative Compound No. M-14 (Example 84),
 50 compound Illustrative Compound No. M-17 (Example 85),
 compound Illustrative Compound No. M-20 (Example 86),
 compound Illustrative Compound No. M-22 (Example 87),
 compound Illustrative Compound No. M-24 (Example 88),
 compound Illustrative Compound No. N-1 (Example 89),
 55 compound Illustrative Compound No. N-24 (Example 90),
 compound Illustrative Compound No. O-3 (Example 91),
 compound Illustrative Compound No. O-15 (Example 92),
 compound Illustrative Compound No. O-21 (Example 93),

compound Illustrative Compound No. P-1 (Example 94),
 compound Illustrative Compound No. P-16 (Example 95),
 compound Illustrative Compound No. P-31 (Example 96),
 compound Illustrative Compound No. Q-1 (Example 97),
 compound Illustrative Compound No. Q-6 (Example 98) and
 compound Illustrative Compound No. Q-31 (Example 99). When a DC voltage of 12 V was applied to each element in
 a dry atmosphere, luminescence of a blue to bluish green color was identified. Further, the characteristics thereof were
 measured, and the results were shown in Tables 9 to 13.

Comparative Example 1

[0146] An organic electroluminescent element was produced by the process described in Example 1 except that in
 the formation of the luminescent layer in Example 1, only bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum
 was used without using compound Illustrative Compound No. A-5 and the deposition was conducted to a thickness of
 50 nm to form a luminescent layer. When a DC voltage of 12 V was applied to this element in a dry atmosphere,
 luminescence of a blue color was identified. Further, the characteristics thereof were measured, and the results were
 shown in Table 13.

Comparative Example 2

[0147] An organic electroluminescent element was produced by the process described in Example 1 except that in
 the formation of the luminescent layer in Example 1, N-methyl-2-methoxyacridone was used instead of using compound
 Illustrative Compound No. A-5. When a DC voltage of 12 V was applied to this element in a dry atmosphere, lumines-
 cence of a blue color was identified. Further, the characteristics thereof were measured, and the results were shown
 in Table 13.

Table 9

Organic electroluminescent element	Brightness (cd/m ²)	Current density (mA/cm ²)
Example 2	2380	54
Example 3	2360	55
Example 4	2320	54
Example 5	2360	53
Example 6	2440	56
Example 7	2340	56
Example 8	2330	55
Example 9	2380	54
Example 10	2380	54
Example 11	2350	56
Example 12	2440	54
Example 13	2480	53
Example 14	2390	55
Example 15	2340	54
Example 16	2510	55
Example 17	2340	53
Example 18	2420	56
Example 19	2430	54
Example 20	2420	54
Example 21	2340	55

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Table 9 (continued)

Organic electroluminescent element	Brightness (cd/m ²)	Current density (mA/cm ²)
Example 22	2440	54
Example 23	2410	53
Example 24	2350	55
Example 25	2510	55

Table 10

Organic electroluminescent element	Brightness (cd/m ²)	Current density (mA/cm ²)
Example 26	2370	54
Example 27	2320	54
Example 28	2340	54
Example 29	2360	56
Example 30	2330	55
Example 31	2370	54
Example 32	2380	55
Example 33	2460	54
Example 34	2340	54
Example 35	2580	56
Example 36	2340	54
Example 37	2410	55
Example 38	2380	55
Example 39	2380	55
Example 40	2420	54
Example 41	2410	53
Example 42	2350	56
Example 43	2340	56
Example 44	2380	55
Example 45	2500	56
Example 46	2360	55
Example 47	2340	56
Example 48	2320	55
Example 49	2330	56

Table 11

Organic electroluminescent element	Brightness (cd/m ²)	Current density (mA/cm ²)
Example 50	2540	56
Example 51	2360	54
Example 52	2340	55
Example 53	2380	54

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Table 11 (continued)

Organic electroluminescent element	Brightness (cd/m ²)	Current density (mA/cm ²)
Example 54	2350	56
Example 55	2470	55
Example 56	2330	56
Example 57	2350	53
Example 58	2460	55
Example 59	2340	53
Example 60	2420	55
Example 61	2530	56
Example 62	2440	54
Example 63	2360	53
Example 64	2340	55
Example 65	2380	54
Example 66	2410	56
Example 67	2390	55
Example 68	2340	56
Example 69	2350	54
Example 70	2370	55
Example 71	2420	56
Example 72	2480	55
Example 73	2510	56

Table 12

Organic electroluminescent element	Brightness (cd/m ²)	Current density (mA/cm ²)
Example 74	2380	53
Example 75	2460	54
Example 76	2340	55
Example 77	2480	55
Example 78	2350	54
Example 79	2370	55
Example 80	2510	56
Example 81	2330	56
Example 82	2340	55
Example 83	2350	53
Example 84	2350	55
Example 85	2430	56
Example 86	2340	56
Example 87	2370	55
Example 88	2320	56

Table 12 (continued)

Organic electroluminescent element	Brightness (cd/m ²)	Current density (mA/cm ²)
Example 89	2380	54
Example 90	2350	56
Example 91	2370	55
Example 92	2340	56
Example 93	2350	54
Example 94	2370	55
Example 95	2420	56
Example 96	2480	55
Example 97	2510	56

Table 13

Organic electroluminescent element	Brightness (cd/m ²)	Current density (mA/cm ²)
Example 98	2460	56
Example 99	2380	55
Comparative Example 1	1170	82
Comparative Example 2	1550	74

Example 100

[0148] A glass substrate with an ITO transparent electrode (anode) having a thickness of 200 nm was ultrasonically cleaned using a neutral detergent, acetone and ethanol. This substrate was dried using a nitrogen gas, further subjected to UV/ozone cleaning, and then fixed on a substrate holder of a deposition device. Thereafter, a deposition bath was set at reduced pressure of 4×10^{-4} Pa.

[0149] First, 4,4',4"-tris[N-(3"-methylphenyl)-N-phenylamino]triphenylamine was deposited on the ITO transparent electrode to a thickness of 50 nm at a deposition rate of 0.1 nm/sec to form a first hole injection transport layer.

[0150] Then, 4,4'-bis[N-phenyl-N-(1"-naphthyl)amino]biphenyl and compound Illustrative Compound No. A-5 were co-deposited from different deposition sources to a thickness of 20 nm at a deposition rate of 0.2 nm/sec (weight ratio 100:5.0) to form a luminescent layer serving also as a second hole injection transport layer.

[0151] Subsequently, tris(8-quinolinolato)aluminum was deposited thereon to a thickness of 50 nm at a deposition rate of 0.2 nm/sec to form an electron injection transport layer.

[0152] Further, magnesium and silver were co-deposited thereon to a thickness of 200 nm at a deposition rate of 0.2 nm/sec (weight ratio 10:1) to form a cathode, and an organic electroluminescent element was produced. By the way, the deposition was conducted while maintaining the state of reduced pressure of the deposition bath.

[0153] When a DC voltage of 15 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 62 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,620 cd/m² was identified.

Examples 101 to 162

[0154] Organic electroluminescent elements were produced by the process described in Example 100 except using, instead of using compound Illustrative Compound A-5 in the formation of the luminescent layer in Example 100, compound Illustrative Compound No. A-6 (Example 101), compound Illustrative Compound No. A-8 (Example 102), compound Illustrative Compound No. A-9 (Example 103), compound Illustrative Compound No. A-11 (Example 104), compound Illustrative Compound No. A-14 (Example 105), compound Illustrative Compound No. A-17 (Example 106), compound Illustrative Compound No. A-19 (Example 107),

compound illustrative Compound No. A-21 (Example 108),
 compound illustrative Compound No. A-23 (Example 109),
 compound illustrative Compound No. A-40 (Example 110),
 compound illustrative Compound No. A-43 (Example 111),
 5 compound illustrative Compound No. A-45 (Example 112),
 compound illustrative Compound No. A-47 (Example 113),
 compound illustrative Compound No. A-53 (Example 114),
 compound illustrative Compound No. A-55 (Example 115),
 compound illustrative Compound No. A-58 (Example 116),
 10 compound illustrative Compound No. B-1 (Example 117),
 compound illustrative Compound No. B-2 (Example 118),
 compound illustrative Compound No. B-6 (Example 119),
 compound illustrative Compound No. B-9 (Example 120),
 compound illustrative Compound No. B-12 (Example 121),
 15 compound illustrative Compound No. B-14 (Example 122),
 compound illustrative Compound No. B-17 (Example 123),
 compound illustrative Compound No. B-19 (Example 124),
 compound illustrative Compound No. B-21 (Example 125),
 compound illustrative Compound No. B-25 (Example 126),
 20 compound illustrative Compound No. B-40 (Example 127),
 compound illustrative Compound No. B-43 (Example 128),
 compound illustrative Compound No. B-45 (Example 129),
 compound illustrative Compound No. B-47 (Example 130),
 compound illustrative Compound No. B-53 (Example 131),
 25 compound illustrative Compound No. B-55 (Example 132),
 compound illustrative Compound No. B-58 (Example 133),
 compound illustrative Compound No. C-1 (Example 134),
 compound illustrative Compound No. C-3 (Example 135),
 compound illustrative Compound No. C-5 (Example 136),
 30 compound illustrative Compound No. C-12 (Example 137),
 compound illustrative Compound No. C-14 (Example 138),
 compound illustrative Compound No. C-20 (Example 139),
 compound illustrative Compound No. C-25 (Example 140),
 compound illustrative Compound No. D-1 (Example 141),
 35 compound illustrative Compound No. D-8 (Example 142),
 compound illustrative Compound No. E-1 (Example 143),
 compound illustrative Compound No. F-3 (Example 144),
 compound illustrative Compound No. G-1 (Example 145),
 compound illustrative Compound No. H-1 (Example 146),
 40 compound illustrative Compound No. I-1 (Example 147),
 compound illustrative Compound No. I-4 (Example 148),
 compound illustrative Compound No. J-3 (Example 149),
 compound illustrative Compound No. K-3 (Example 150),
 compound illustrative Compound No. L-1 (Example 151),
 45 compound illustrative Compound No. M-1 (Example 152),
 compound illustrative Compound No. M-3 (Example 153),
 compound illustrative Compound No. M-5 (Example 154),
 compound illustrative Compound No. M-14 (Example 155),
 compound illustrative Compound No. M-20 (Example 156),
 50 compound illustrative Compound No. M-22 (Example 157),
 compound illustrative Compound No. M-24 (Example 158),
 compound illustrative Compound No. N-1 (Example 159),
 compound illustrative Compound No. O-3 (Example 160),
 compound illustrative Compound No. P-1 (Example 161) and
 55 compound illustrative Compound No. Q-1 (Example 162). When a DC voltage of 15 V was applied to each element in
 a dry atmosphere, luminescence of a blue to bluish green color was identified. Further, the characteristics thereof were
 measured, and the results were shown in Tables 14 to 16.

Table 14

Organic electroluminescent element	Brightness (cd/m ²)	Current density (mA/cm ²)
Example 101	2450	56
Example 102	2470	54
Example 103	2640	54
Example 104	2630	56
Example 105	2580	57
Example 106	2530	55
Example 107	2520	54
Example 108	2480	55
Example 109	2520	57
Example 110	2480	54
Example 111	2540	55
Example 112	2590	57
Example 113	2480	57
Example 114	2620	55
Example 115	2490	56
Example 116	2550	54
Example 117	2640	63
Example 118	2470	55
Example 119	2450	56
Example 120	2620	54
Example 121	2610	54
Example 122	2570	56
Example 123	2550	55
Example 124	2580	56

Table 15

Organic electroluminescent element	Brightness (cd/m ²)	Current density (mA/cm ²)
Example 125	2460	54
Example 126	2520	57
Example 127	2460	57
Example 128	2540	54
Example 129	2590	56
Example 130	2580	57
Example 131	2520	55
Example 132	2490	55
Example 133	2620	54
Example 134	2510	55

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Table 15 (continued)

Organic electroluminescent element	Brightness (cd/m ²)	Current density (mA/cm ²)
Example 135	2600	54
Example 136	2630	56
Example 137	2610	57
Example 138	2550	56
Example 139	2670	55
Example 140	2570	56
Example 141	2640	63
Example 142	2470	55
Example 143	2550	56
Example 144	2620	57
Example 145	2610	58
Example 146	2570	56
Example 147	2550	55
Example 148	2480	54

Table 16

Organic electroluminescent element	Brightness (cd/m ²)	Current density (mA/cm ²)
Example 149	2450	53
Example 150	2470	54
Example 151	2540	56
Example 152	2510	55
Example 153	2560	54
Example 154	2630	55
Example 155	2570	56
Example 156	2620	55
Example 157	2610	57
Example 158	2590	55
Example 159	2440	55
Example 160	2590	57
Example 161	2460	54

Example 163

[0155] A glass substrate with an ITO transparent electrode (anode) having a thickness of 200 nm was ultrasonically cleaned using a neutral detergent, acetone and ethanol. This substrate was dried using a nitrogen gas, further subjected to UV/ozone cleaning, and then fixed on a substrate holder of a deposition device. Thereafter, a deposition bath was set at reduced pressure of 4×10^{-4} Pa.

[0156] First, 4,4'-bis[N-phenyl-N-(3"-methylphenyl)amino]biphenyl was deposited on the ITO transparent electrode to a thickness of 75 nm at a deposition rate of 0.2 nm/sec to form a hole injection transport layer.

[0157] Then, bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound No.

A-6 were co-deposited thereon from different deposition sources to a thickness of 50 nm at a deposition rate of 0.2 nm/sec (weight ratio 100:1.0) to form a luminescent layer.

[0158] Subsequently, tris(8-quinolinolato)aluminum was deposited to a thickness of 50 nm at a deposition rate of 0.2 nm/sec to form an electron injection transport layer.

[0159] Further, magnesium and silver were co-deposited thereon to a thickness of 200 nm at a deposition rate of 0.2 nm/sec (weight ratio 10:1) to form a cathode, and an organic electroluminescent element was produced. By the way, the deposition was conducted while maintaining the state of reduced pressure of the deposition bath.

[0160] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 55 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,440 cd/m² was identified.

Example 164

[0161] An organic electroluminescent element was produced by the process described in Example 163 except that in the formation of the luminescent layer in Example 163, bis(2-methyl-8-quinolinolato)aluminum-μ-oxo-bis(2-methyl-8-quinolinolato)aluminum and compound Illustrative Compound No. A-21 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-6 and were co-deposited to a thickness of 50 nm (weight ratio 100:2.0) to form a luminescent layer.

[0162] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 55 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,350 cd/m² was identified.

Example 165

[0163] An organic electroluminescent element was produced by the process described in Example 163 except that in the formation of the luminescent layer in Example 163, bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound No. A-40 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-6 and were co-deposited to a thickness of 50 nm (weight ratio 100:1.0) to form a luminescent layer.

[0164] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 54 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,320 cd/m² was identified.

Example 166

[0165] An organic electroluminescent element was produced by the process described in Example 163 except that in the formation of the luminescent layer in Example 163, tris(8-quinolinolato)aluminum and compound Illustrative Compound No. B-1 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-6 and were co-deposited to a thickness of 50 nm (weight ratio 100:3.0) to form a luminescent layer.

[0166] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 54 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,370 cd/m² was identified.

Example 167

[0167] An organic electroluminescent element was produced by the process described in Example 163 except that in the formation of the luminescent layer in Example 163, tris(8-quinolinolato)aluminum and compound Illustrative Compound No. B-12 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-6 and were co-deposited to a thickness of 50 nm (weight ratio 100:6.0) to form a luminescent layer.

[0168] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 54 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,360 cd/m² was identified.

Example 168

[0169] An organic electroluminescent element was produced by the process described in Example 163 except that

in the formation of the luminescent layer in Example 163, bis(2-methyl-8-quinolinolato)aluminum- μ -oxo-bis(2-methyl-8-quinolinolato)aluminum and compound Illustrative Compound No. C-1 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-6 and were co-deposited to a thickness of 50 nm (weight ratio 100:2.0) to form a luminescent layer.

When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 55 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,350 cd/m² was identified.

Example 169

[0170] An organic electroluminescent element was produced by the process described in Example 163 except that in the formation of the luminescent layer in Example 163, tris(8-quinolinolato)aluminum and compound Illustrative Compound No. C-12 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-6 and were co-deposited to a thickness of 50 nm (weight ratio 100:10.0) to form a luminescent layer.

[0171] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 55 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,440 cd/m² was identified.

Example 170

[0172] An organic electroluminescent element was produced by the process described in Example 163 except that in the formation of the luminescent layer in Example 163, bis(2,4-dimethyl-8-quinolinolato)aluminum- μ -oxo-bis(2,4-dimethyl-8-quinolinolato)aluminum and compound Illustrative Compound No. D-1 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-6 and were co-deposited to a thickness of 50 nm (weight ratio 100:1.0) to form a luminescent layer. When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 54 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,320 cd/m² was identified.

Example 171

[0173] An organic electroluminescent element was produced by the process described in Example 163 except that in the formation of the luminescent layer in Example 163, bis(2-methyl-8-quinolinolato)aluminum- μ -oxo-bis(2-methyl-8-quinolinolato)aluminum and compound Illustrative Compound No. E-1 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-6 and were co-deposited to a thickness of 50 nm (weight ratio 100:2.0) to form a luminescent layer. When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 54 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,380 cd/m² was identified.

Example 172

[0174] An organic electroluminescent element was produced by the process described in Example 163 except that in the formation of the luminescent layer in Example 163, bis(2,4-dimethyl-8-quinolinolato)aluminum- μ -oxo-bis(2,4-dimethyl-8-quinolinolato)aluminum and compound Illustrative Compound No. F-3 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-6 and were co-deposited to a thickness of 50 nm (weight ratio 100:4.0) to form a luminescent layer. When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 55 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,340 cd/m² was identified.

Example 173

[0175] An organic electroluminescent element was produced by the process described in Example 163 except that in the formation of the luminescent layer in Example 163, tris(8-quinolinolato)aluminum and compound Illustrative Compound No. M-1 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-6 and were co-deposited to a thickness of 50 nm (weight ratio 100:3.0) to form a luminescent layer.

[0176] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 57 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,380 cd/m²

was identified.

Example 174

[0177] An organic electroluminescent element was produced by the process described in Example 163 except that in the formation of the luminescent layer in Example 163, tris(8-quinolinolato)aluminum and compound Illustrative Compound No. M-20 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-6 and were co-deposited to a thickness of 50 nm (weight ratio 100:6.0) to form a luminescent layer.

[0178] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 58 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,350 cd/m² was identified.

Example 175

[0179] A glass substrate with an ITO transparent electrode (anode) having a thickness of 200 nm was ultrasonically cleaned using a neutral detergent, acetone and ethanol. This substrate was dried using a nitrogen gas, further subjected to UV/ozone cleaning, and then fixed on a substrate holder of a deposition device. Thereafter, a deposition bath was set at reduced pressure of 4×10^{-4} Pa.

[0180] First, 4,4',4"-tris[N-(3"-methylphenyl)-N-phenylamino]triphenylamine was deposited on the ITO transparent electrode to a thickness of 30 nm at a deposition rate of 0.1 nm/sec to form a first hole injection transport layer.

[0181] Next, 4,4'-bis[N-phenyl-N-(3"-methylphenyl)amino]biphenyl was deposited thereon to a thickness of 45 nm at a deposition rate of 0.2 nm/sec to form a second hole injection transport layer.

[0182] Then, bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound No. A-5 were co-deposited thereon from different deposition sources to a thickness of 50 nm at a deposition rate of 0.2 nm/sec (weight ratio 100:2.0) to form a luminescent layer.

[0183] Subsequently, tris(8-quinolinolato)aluminum was deposited to a thickness of 50 nm at a deposition rate of 0.2 nm/sec to form an electron injection transport layer.

[0184] Further, magnesium and silver were co-deposited thereon to a thickness of 200 nm at a deposition rate of 0.2 nm/sec (weight ratio 10:1) to form a cathode, and an organic electroluminescent element was produced. By the way, the deposition was conducted while maintaining the state of reduced pressure of the deposition bath.

[0185] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 56 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,780 cd/m² was identified.

Example 176

[0186] An organic electroluminescent element was produced by the process described in Example 175 except that in the formation of the luminescent layer in Example 175, bis(2,4-dimethyl-8-quinolinolato)aluminum-μ-oxo-bis(2,4-dimethyl-8-quinolinolato)aluminum and compound Illustrative Compound No. B-1 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-5 and were co-deposited to a thickness of 50 nm (weight ratio 100:1.0) to form a luminescent layer. When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 55 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,680 cd/m² was identified.

Example 177

[0187] An organic electroluminescent element was produced by the process described in Example 175 except that in the formation of the luminescent layer in Example 175, bis(2-methyl-8-quinolinolato)aluminum-μ-oxo-bis(2-methyl-8-quinolinolato)aluminum and compound Illustrative Compound No. C-1 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-5 and were co-deposited to a thickness of 50 nm (weight ratio 100:3.0) to form a luminescent layer.

When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 57 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,650 cd/m² was identified.

Example 178

[0188] An organic electroluminescent element was produced by the process described in Example 175 except that in the formation of the luminescent layer in Example 175, tris(8-quinolinolato)aluminum and compound Illustrative Compound No. D-1 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-5 and were co-deposited to a thickness of 50 nm (weight ratio 100:2.0) to form a luminescent layer.

When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 55 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,420 cd/m² was identified.

Example 179

[0189] An organic electroluminescent element was produced by the process described in Example 175 except that in the formation of the luminescent layer in Example 175, bis(2-methyl-8-quinolinolato)aluminum-μ-oxo-bis(2-methyl-8-quinolinolato)aluminum and compound Illustrative Compound No. F-24 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-5 and were co-deposited to a thickness of 50 nm (weight ratio 100:4.0) to form a luminescent layer.

When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 58 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,600 cd/m² was identified.

Example 180

[0190] An organic electroluminescent element was produced by the process described in Example 175 except that in the formation of the luminescent layer in Example 175, tris(8-quinolinolato)aluminum and compound Illustrative Compound No. G-1 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-5 and were co-deposited to a thickness of 50 nm (weight ratio 100:2.0) to form a luminescent layer.

When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 54 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,480 cd/m² was identified.

Example 181

[0192] An organic electroluminescent element was produced by the process described in Example 175 except that in the formation of the luminescent layer in Example 175, bis(2,4-dimethyl-8-quinolinolato)aluminum-μ-oxo-bis(2,4-dimethyl-8-quinolinolato)aluminum and compound Illustrative Compound No. K-3 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-5 and were co-deposited to a thickness of 50 nm (weight ratio 100:2.0) to form a luminescent layer. When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 53 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,510 cd/m² was identified.

Example 182

[0193] An organic electroluminescent element was produced by the process described in Example 175 except that in the formation of the luminescent layer in Example 175, bis(2,4-dimethyl-8-quinolinolato)aluminum-μ-oxo-bis(2,4-dimethyl-8-quinolinolato)aluminum and compound Illustrative Compound No. M-1 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-5 and were co-deposited to a thickness of 50 nm (weight ratio 100:3.0) to form a luminescent layer. When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 56 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,530 cd/m² was identified.

Example 183

[0194] A glass substrate with an ITO transparent electrode (anode) having a thickness of 200 nm was ultrasonically cleaned using a neutral detergent, acetone and ethanol. This substrate was dried using a nitrogen gas, further subjected to UV/ozone cleaning, and then fixed on a substrate holder of a deposition device. Thereafter, a deposition bath was

set at reduced pressure of 4×10^{-4} Pa.

[0195] First, 4,4'-bis[N-phenyl-N-(3"-methylphenyl)amino]biphenyl was deposited on the ITO transparent electrode to a thickness of 75 nm at a deposition rate of 0.2 nm/sec to form a hole injection transport layer. Then, bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound No. A-20 were co-deposited thereon from different deposition sources to a thickness of 50 nm at a deposition rate of 0.2 nm/sec (weight ratio 100:2.0) to form a luminescent layer.

[0196] Subsequently, 1,3-bis[5'-(4"-tert-butylphenyl)-1',3',4'-oxadiazol-2'-yl]benzene was deposited to a thickness of 50 nm at a deposition rate of 0.2 nm/sec to form an electron injection transport layer.

[0197] Further, magnesium and silver were co-deposited thereon to a thickness of 200 nm at a deposition rate of 0.2 nm/sec (weight ratio 10:1) to form a cathode, and an organic electroluminescent element was produced. By the way, the deposition was conducted while maintaining the state of reduced pressure of the deposition bath.

[0198] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 54 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,320 cd/m² was identified.

Example 184

[0199] An organic electroluminescent element was produced by the process described in Example 183 except that in the formation of the luminescent layer in Example 183, tris(8-quinolinolato)aluminum and compound Illustrative Compound No. E-21 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-20 and were co-deposited to a thickness of 50 nm (weight ratio 100:4.0) to form a luminescent layer. When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 56 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,430 cd/m² was identified.

Example 185

[0200] An organic electroluminescent element was produced by the process described in Example 183 except that in the formation of the luminescent layer in Example 183, bis(2-methyl-8-quinolinolato)aluminum-μ-oxo-bis(2-methyl-8-quinolinolato)aluminum and compound Illustrative Compound No. L-1 were used instead of using bis(2-methyl-8-quinolinolato)(4-phenylphenolato)aluminum and compound Illustrative Compound A-20 and were co-deposited to a thickness of 50 nm (weight ratio 100:3.0) to form a luminescent layer.

[0201] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 54 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,380 cd/m² was identified.

Example 186

[0202] A glass substrate with an ITO transparent electrode (anode) having a thickness of 200 nm was ultrasonically cleaned using a neutral detergent, acetone and ethanol. This substrate was dried using a nitrogen gas, further subjected to UV/ozone cleaning, and then fixed on a substrate holder of a deposition device. Thereafter, a deposition bath was set at reduced pressure of 4×10^{-4} Pa.

[0203] First, 4,4'-bis[N-phenyl-N-(3"-methylphenyl)amino]biphenyl was deposited on the ITO transparent electrode to a thickness of 75 nm at a deposition rate of 0.2 nm/sec to form a hole injection transport layer.

[0204] Then, compound Illustrative Compound No. B-12 was deposited thereon to a thickness of 50 nm at a deposition rate of 0.2 nm/sec to form a luminescent layer.

[0205] Subsequently, tris(8-quinolinolato)aluminum was deposited to a thickness of 50 nm at a deposition rate of 0.2 nm/sec to form an electron injection transport layer.

[0206] Further, magnesium and silver were co-deposited thereon to a thickness of 200 nm at a deposition rate of 0.2 nm/sec (weight ratio 10:1) to form a cathode, and an organic electroluminescent element was produced. By the way, the deposition was conducted while maintaining the state of reduced pressure of the deposition bath.

[0207] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 58 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,740 cd/m² was identified.

Example 187

[0208] An organic electroluminescent element was produced by the process described in Example 186 except that

in the formation of the luminescent layer in Example 186, compound Illustrative Compound No. J-3 was used instead of using compound Illustrative Compound B-12.

[0209] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 56 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,660 cd/m² was identified.

Example 188

[0210] An organic electroluminescent element was produced by the process described in Example 186 except that in the formation of the luminescent layer in Example 186, compound Illustrative Compound No. L-1 was used instead of using compound Illustrative Compound No. B-12.

When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 54 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,430 cd/m² was identified.

Example 189

[0211] A glass substrate with an ITO transparent electrode (anode) having a thickness of 200 nm was ultrasonically cleaned using a neutral detergent, acetone and ethanol. This substrate was dried using a nitrogen gas, further subjected to UV/ozone cleaning, and then fixed on a substrate holder of a deposition device. Thereafter, a deposition bath was set at reduced pressure of 4×10^{-4} Pa.

[0212] First, 4,4'-bis[N-phenyl-N-(3"-methylphenyl)amino]biphenyl was deposited on the ITO transparent electrode to a thickness of 75 nm at a deposition rate of 0.2 nm/sec to form a hole injection transport layer.

[0213] Subsequently, compound Illustrative Compound No. A-5 was deposited thereon to a thickness of 50 nm at a deposition rate of 0.2 nm/sec to form a luminescent layer. Then, 1,3-bis[5'-(4"-tert-butylphenyl)-1',3',4'-oxadiazol-2'-yl] benzene was deposited thereon to a thickness of 50 nm at a deposition rate of 0.2 nm/sec to form an electron injection transport layer.

[0214] Further, magnesium and silver were co-deposited thereon to a thickness of 200 nm at a deposition rate of 0.2 nm/sec (weight ratio 10:1) to form a cathode, and an organic electroluminescent element was produced. By the way, the deposition was conducted while maintaining the state of reduced pressure of the deposition bath.

[0215] When a DC voltage of 14 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 44 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 1,820 cd/m² was identified.

Example 190

[0216] An organic electroluminescent element was produced by the process described in Example 189 except that in the formation of the luminescent layer in Example 189, compound Illustrative Compound No. A-9 was used instead of using compound Illustrative Compound A-5.

[0217] When a DC voltage of 14 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 44 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 1,820 cd/m² was identified.

Example 191

[0218] An organic electroluminescent element was produced by the process described in Example 189 except that in the formation of the luminescent layer in Example 189, compound Illustrative Compound No. B-55 was used instead of using compound Illustrative Compound A-5.

[0219] When a DC voltage of 14 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 60 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 1,480 cd/m² was identified.

Example 192

[0220] A glass substrate with an ITO transparent electrode (anode) having a thickness of 200 nm was ultrasonically cleaned using a neutral detergent, acetone and ethanol. This substrate was dried using a nitrogen gas, further subjected to UV/ozone cleaning, and then fixed on a substrate holder of a deposition device. Thereafter, a deposition bath was set at reduced pressure of 4×10^{-4} Pa.

[0221] First, 4,4'-bis[N-phenyl-N-(3"-methylphenyl)amino]biphenyl was deposited on the ITO transparent electrode to a thickness of 75 nm at a deposition rate of 0.2 nm/sec to form a hole injection transport layer.

[0222] Then, tris(8-quinolinolato)aluminum and compound Illustrative Compound No. A-17 were co-deposited thereon from different deposition sources to a thickness of 50 nm at a deposition rate of 0.2 nm/sec (weight ratio 100:1.0) to form a luminescent layer serving also as an electron transport layer.

[0223] Further, magnesium and silver were co-deposited thereon to a thickness of 200 nm at a deposition rate of 0.2 nm/sec (weight ratio 10:1) to form a cathode, and an organic electroluminescent element was produced. By the way, the deposition was conducted while maintaining the state of reduced pressure of the deposition bath.

[0224] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 53 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,320 cd/m² was identified.

Example 193

[0225] An organic electroluminescent element was produced by the process described in Example 192 except that in the formation of the luminescent layer in Example 192, tris(8-quinolinolato)aluminum and compound Illustrative Compound No. B-17 were used instead of using tris(8-quinolinolato)aluminum and compound Illustrative Compound No. A-17 and were co-deposited to a thickness of 50 nm (weight ratio 100:1.0) to form a luminescent layer.

[0226] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 54 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,340 cd/m² was identified.

Example 194

[0227] An organic electroluminescent element was produced by the process described in Example 193 except that in the formation of the luminescent layer in Example 193, bis(2-methyl-8-quinolinolato)aluminum-μ-oxo-bis(2-methyl-8-quinolinolato)aluminum and compound Illustrative Compound No. F-24 were used instead of using tris(8-quinolinolato)aluminum and compound Illustrative Compound No. A-17 and were co-deposited to a thickness of 50 nm (weight ratio 100:2.0) to form a luminescent layer.

[0228] When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 54 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 2,330 cd/m² was identified.

Example 195

[0229] A glass substrate with an ITO transparent electrode (anode) having a thickness of 200 nm was ultrasonically cleaned using a neutral detergent, acetone and ethanol. This substrate was dried using a nitrogen gas, further subjected to UV/ozone cleaning, and then fixed on a substrate holder of a deposition device. Thereafter, a deposition bath was set at reduced pressure of 4×10^{-4} Pa.

[0230] First, compound Illustrative Compound No. A-55 was deposited on the ITO transparent electrode to a thickness of 55 nm at a deposition rate of 0.2 nm/sec to form a luminescent layer.

[0231] Then, 1,3-bis[5'-(4"-tert-butylphenyl)-1',3',4'-oxadiazol-2'-yl]benzene was deposited thereon to a thickness of 75 nm at a deposition rate of 0.2 nm/sec to form an electron injection transport layer.

[0232] Further, magnesium and silver were co-deposited thereon to a thickness of 200 nm at a deposition rate of 0.2 nm/sec (weight ratio 10:1) to form a cathode, and an organic electroluminescent element was produced. By the way, the deposition was conducted while maintaining the state of reduced pressure of the deposition bath.

[0233] When a DC voltage of 14 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 60 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 1,500 cd/m² was identified.

Example 196

[0234] An organic electroluminescent element was produced by the process described in Example 195 except that in the formation of the luminescent layer in Example 195, compound Illustrative Compound No. B-55 was used instead of using compound Illustrative Compound A-55.

When a DC voltage of 14 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 60 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 1,480 cd/m² was identified.

Example 197

[0235] A glass substrate with an ITO transparent electrode (anode) having a thickness of 200 nm was ultrasonically cleaned using a neutral detergent, acetone and ethanol. This substrate was dried using a nitrogen gas, and further subjected to UV/ozone cleaning

[0236] Then, a luminescent layer of 400 nm was formed on the ITO transparent electrode by a dip coating method using a 3 % by weight dichloroethane solution containing poly-N-vinylcarbazole (weight average molecular weight 150,000), compound Illustrative Compound No. B-12, coumalin 6 [³-(2'-benzothiazolyl)-7-diethylaminocoumarin" (luminescent component of a green color)] and DCM-1 [⁴-(dicyanomethylene)-2-methyl-6-(4'-dimethylaminostyryl)-4H-pyran" (luminescent component of an orange color)] at a weight ratio of 100:5:3:2 respectively.

[0237] Then, the glass substrate having the luminescent layer was fixed on a substrate holder of a deposition device, and a deposition bath was set at reduced pressure of 4×10^{-4} Pa. In addition, 3-(4'-tert-butylphenyl)-4-phenyl-5-(4'-phenylphenyl)-1,2,4-triazole was deposited on the luminescent layer to a thickness of 20 nm at a deposition rate of 0.2 nm/sec, and tris(8-quinolinolato)aluminum was further deposited thereon to a thickness of 30 nm at a deposition rate of 0.2 nm/sec to form an electron injection transport layer.

[0238] Further, magnesium and silver were co-deposited thereon to a thickness of 200 nm at a deposition rate of 0.2 nm/sec (weight ratio 10:1) to form a cathode, and an organic electroluminescent element was produced. When a DC voltage of 12 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 73 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 1,350 cd/m² was identified.

Examples 198 to 205

[0239] Organic electroluminescent elements were produced by the process described in Example 197 except using, instead of using compound Illustrative Compound No. B-12 in Example 197, compound Illustrative Compound No. B-43 (Example 198), compound Illustrative Compound No. C-3 (Example 199), compound Illustrative Compound No. C-5 (Example 200), compound Illustrative Compound No. E-7 (Example 201), compound Illustrative Compound No. E-18 (Example 202), compound Illustrative Compound No. F-24 (Example 203), compound Illustrative Compound No. I-4 (Example 204) and compound Illustrative Compound No. M-5 (Example 205). When a DC voltage of 12 V was applied to each element in a dry atmosphere, luminescence of a white color was observed. Further, the characteristics thereof were measured, and the results were shown in Table 17.

Table 17

Organic electroluminescent element	Brightness (cd/m ²)	Current density (mA/cm ²)
Example 198	1280	76
Example 199	1250	74
Example 200	1240	76
Example 201	1260	75
Example 202	1340	75
Example 203	1230	73
Example 204	1380	75
Example 205	1260	74

Example 206

[0240] A glass substrate with an ITO transparent electrode (anode) having a thickness of 200 nm was ultrasonically cleaned using a neutral detergent, acetone and ethanol. This substrate was dried using a nitrogen gas, and further subjected to UV/ozone cleaning

[0241] Then, a luminescent layer of 300 nm was formed on the ITO transparent electrode by a dip coating method using a 3 % by weight dichloroethane solution containing poly-N-vinylcarbazole (weight average molecular weight 150,000), 1,3-bis[5'-(4'-tert-butylphenyl)-1',3',4'-oxadiazolyl-2'-yl]benzene and compound Illustrative Compound No. C-3 at a weight ratio of 100:30:3 respectively. Subsequently, the glass substrate having the luminescent layer was

fixed on a substrate holder of a deposition device, and a deposition bath was set at reduced pressure of 4×10^{-4} Pa.

[0242] Further, magnesium and silver were co-deposited thereon to a thickness of 200 nm at a deposition rate of 0.2 nm/sec (weight ratio 10:1) to form a cathode, and an organic electroluminescent element was produced. When a DC voltage of 15 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 66 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 1,520 cd/m² was identified.

Example 207

[0243] An organic electroluminescent element was produced by the process described in Example 206 except that in the formation of the luminescent layer in Example 206, compound Illustrative Compound No. M-3 was used instead of using compound Illustrative Compound No. C-3.

[0244] When a DC voltage of 15 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 65 mA/cm² was passed. Luminescence of a blue color having a brightness of 1,540 cd/m² was identified.

Comparative Example 3

[0245] An organic electroluminescent element was produced by the process described in Example 206 except that in the formation of the luminescent layer in Example 206, 1,1,4,4-tetraphenyl-1,3-butadiene was used instead of using compound Illustrative Compound No. C-3.

When a DC voltage of 15 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 86 mA/cm² was passed. Luminescence of a blue color having a brightness of 760 cd/m² was identified.

Example 208

[0246] A glass substrate with an ITO transparent electrode (anode) having a thickness of 200 nm was ultrasonically cleaned using a neutral detergent, acetone and ethanol. This substrate was dried using a nitrogen gas, and further subjected to UV/ozone cleaning.

[0247] Subsequently, a luminescent layer of 300 nm was formed on the ITO transparent electrode by a dip coating method using a 3 % by weight dichloroethane solution containing polycarbonate (weight average molecular weight 50,000), 4,4'-bis[N-phenyl-N-(3"-methylphenyl)amino]biphenyl, bis(2-methyl-8-quinolinolato)aluminum-μ-oxo-bis(2-methyl-8-quinolinolato)aluminum and compound Illustrative Compound No. A-53 at a weight ratio of 100:40:60:1 respectively. Then, the glass substrate having the luminescent layer was fixed on a substrate holder of a deposition device, and a deposition bath was set at reduced pressure of 4×10^{-4} Pa.

[0248] Further, magnesium and silver were co-deposited on the luminescent layer to a thickness of 200 nm at a deposition rate of 0.2 nm/sec (weight ratio 10:1) to form a cathode, and an organic electroluminescent element was produced. When a DC voltage of 15 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 61 mA/cm² was passed. Luminescence of a bluish green color having a brightness of 960 cd/m² was identified.

Example 209

[0249] An organic electroluminescent element was produced by the process described in Example 208 except that in the formation of the luminescent layer in Example 208, compound Illustrative Compound No. B-53 was used instead of using compound Illustrative Compound No. A-53.

[0250] When a DC voltage of 15 V was applied to the organic electroluminescent element produced in a dry atmosphere, a current of 62 mA/cm² was passed. Luminescence of a blue color having a brightness of 970 cd/m² was identified.

Example 210

[0251] A glass substrate with an ITO transparent electrode (anode) having a thickness of 200 nm was ultrasonically cleaned using a neutral detergent, acetone and ethanol. This substrate was dried using a nitrogen gas, further subjected to UV/ozone cleaning, and then fixed on a substrate holder of a deposition device. Thereafter, a deposition bath was set at reduced pressure of 4×10^{-4} Pa.

[0252] First, 4,4'-bis[N-phenyl-N-(1'-naphthyl)amino]biphenyl was deposited on the ITO transparent electrode to a thickness of 75 nm at a deposition rate of 0.2 nm to form a hole injection transport layer.

[0253] Then, tris(8-quinolinolato)aluminum and compound Illustrative Compound No. A-5 were co-deposited thereon

from different deposition sources at a deposition rate of 0.2 nm/sec (weight ratio 100:3.0) to form a luminescent layer.

[0254] Next, tris(8-quinolinolato)aluminum was deposited to a thickness of 50 nm at a deposition rate of 0.2 nm/sec to form an electron injection transport layer.

[0255] Further, magnesium and silver were thereon at a deposition rate of 0.2 nm/sec, and an electroluminescent element was produced. By the way, the deposition was conducted while maintaining the state of reduced pressure of the deposition bath.

[0256] The organic electroluminescent element produced was continuously driven in a dry atmosphere at a constant current density of 10 mA/cm². Luminescence of a bluish green color with 6.7 V and a brightness of 520 cd/m² was identified at the initial stage. A half-life of the brightness was 2,400 hours.

Examples 211 to 218

[0257] Organic electroluminescent elements were produced by the process described in Example 210 except using, instead of using compound Illustrative Compound No. A-5 in Example

210, compound Illustrative Compound No. A-6 (Example 211),

compound Illustrative Compound No. A-23 (Example 212),

compound Illustrative Compound No. B-1 (Example 213),

compound Illustrative Compound No. B-3 (Example 214),

compound Illustrative Compound No. B-24 (Example 215),

compound Illustrative Compound No. C-1 (Example 216),

compound Illustrative Compound No. C-28 (Example 217) and

compound Illustrative Compound No. M-1 (Example 218).

[0258] Each element was continuously driven in a dry atmosphere at a constant current density of 10 mA/cm². Luminescence of a blue to bluish green color was identified from each element. Further, the characteristics thereof were measured, and the results were shown in Table 18.

Comparative Example 4

[0259] An organic electroluminescent element was produced by the process described in Example 210 except that in the formation of the luminescent layer in Example 210, 9,10-diphenylanthracene was used instead of using compound Illustrative Compound No. A-5.

[0260] The organic electroluminescent element produced was continuously driven in a dry atmosphere at a constant current density of 10 mA/cm². Luminescence of a blue color was identified from the element. Further, the characteristics thereof were measured, and the results were shown in Table 18.

Table 18

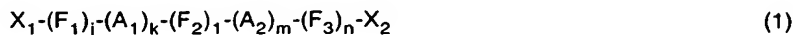
Organic electroluminescent element	Initial characteristics (cd/m ²)	Brightness Voltage (V)	Half-life (hr)
Example 211	530	6.5	2400
Example 212	550	6.4	2300
Example 213	540	6.6	2400
Example 214	560	6.5	2500
Example 215	540	6.6	2300
Example 216	540	6.5	2500
Example 217	530	6.5	2400
Example 218	560	6.4	2200
Comparative Example 4	430	7.2	900

Industrial Applicability

[0261] The invention has made it possible to provide an organic electroluminescent element having an excellent luminescent brightness and a long luminescent life, and further to provide hydrocarbon compounds suited for the luminescent element.

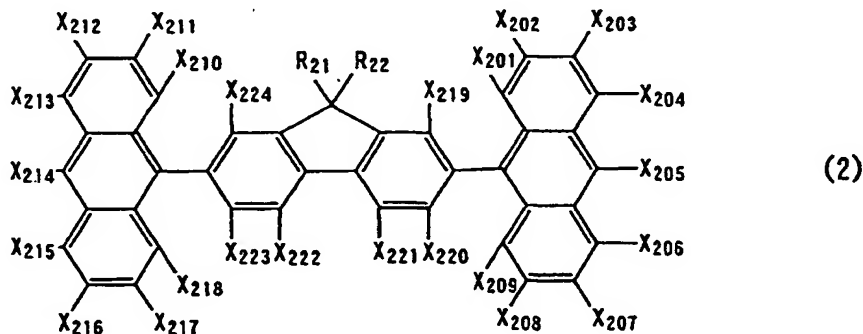
Claims

1. Hydrocarbon compounds in which an anthracene ring and a fluorene ring are directly bound.
2. The hydrocarbon compounds according to claim 1, wherein the fluorene ring is bound in the position except the 9-position.
3. Hydrocarbon compounds represented by the formula (1)



wherein A_1 and A_2 , independently from each other, represent a substituted or unsubstituted anthracen-diyl group, F_1 , F_2 and F_3 , independently from each other, represent a substituted or unsubstituted fluoren-diyl group, X_1 and X_2 , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, j , m and n represent 0 or 1, k and l represent 1 or 2, when k is 2 A_1 's may be the same or different, and when 1 is 2 F_2 's may be the same or different.

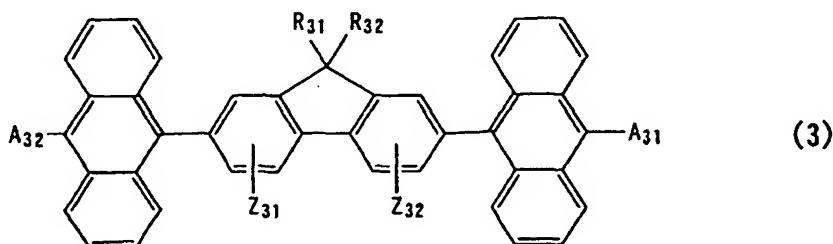
4. The hydrocarbon compounds according to claim 3, wherein k is 1.
5. The hydrocarbon compounds according to claim 1, wherein A_1 and A_2 are an anthracen-9,10-diyl group, and F_1 , F_2 and F_3 are a fluoren-2,7-diyl group.
6. The hydrocarbon compounds according to claim 3, wherein j and n are 0, 1 is 1, and $k + m$ is 2.
7. The hydrocarbon compounds according to claim 6, wherein A_1 and A_2 are an anthracen-9,10-diyl group, and F_2 is a fluoren-2,7-diyl group.
8. The hydrocarbon compounds according to claim 3, wherein $j + 1 + n$ is 2, k is 1, and m is 0.
9. The hydrocarbon compounds according to claim 8, wherein A_1 is an anthracen-9,10-diyl group, and F_1 , F_2 and F_3 are a fluoren-2,7-diyl group.
10. The hydrocarbon compounds according to claim 3, wherein j , m and n are 0, and k and 1 are 1.
11. The hydrocarbon compounds according to claim 10, wherein A_1 is an anthracen-9,10-diyl group, and F_2 is a fluoren-2,7-diyl group.
12. Hydrocarbon compounds represented by the formula (2)



wherein R_{21} and R_{22} , independently from each other, represent a hydrogen atom, a linear, branched or cyclic alkyl

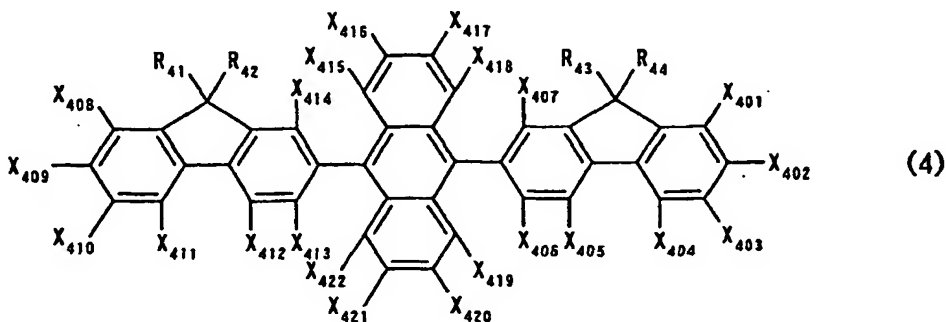
group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, and X_{201} to X_{214} , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, or a substituted or unsubstituted aryl group, provided R_{21} , R_{22} and X_{201} to X_{224} are not an anthryl group or a fluorenyl group.

13. The hydrocarbon compounds according to claim 12, wherein X_{205} and X_{214} are a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, or a substituted or unsubstituted aryl group.
14. The hydrocarbon compounds according to claim 12, wherein X_{205} and X_{214} are a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, or a substituted or unsubstituted heterocyclic aromatic group.
15. The hydrocarbon compounds according to claim 12, wherein X_{201} , X_{204} , X_{206} , X_{209} , X_{210} , X_{213} , X_{215} and X_{218} are a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, or a linear, branched or cyclic alkoxy group.
16. Hydrocarbon compounds represented by the formula (3)



wherein R_{31} and R_{32} , independently from each other, represent a hydrogen atom, a linear, branched or cyclic alkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, A_{31} and A_{32} , independently from each other, represent a substituted or unsubstituted aryl group, and Z_{31} and Z_{32} , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, or a substituted or unsubstituted aryl group.

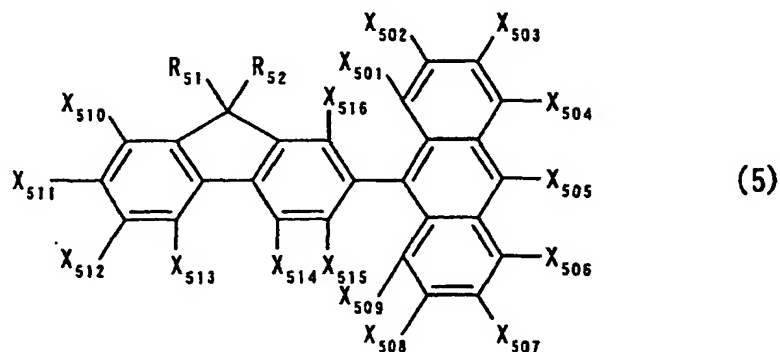
17. Hydrocarbon compounds represented by the formula (4)



wherein R_{41} to R_{44} , independently from each other, represent a hydrogen atom, a linear, branched or cyclic alkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, and X_{401} to X_{422} , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, or a substituted or unsubstituted aryl group, provided R_{41} to R_{44} and X_{401} to X_{422} are not an anthryl group or a fluorenyl group.

18. The hydrocarbon compounds according to claim 17, wherein X_{415} , X_{418} , X_{419} and X_{422} are a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, or a linear, branched or cyclic alkoxy group.

19. Hydrocarbon compounds represented by the formula (5)

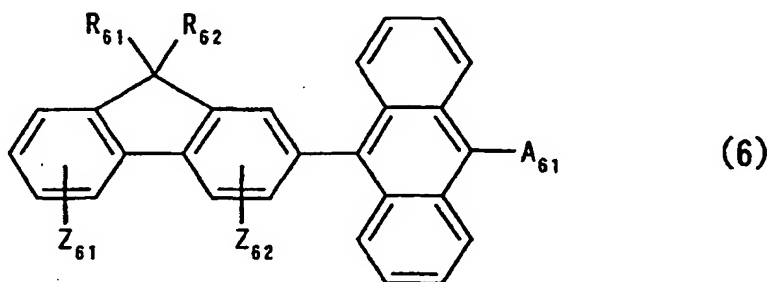


wherein R_{51} and R_{52} , independently from each other, represent a hydrogen atom, a linear, branched or cyclic alkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, and X_{501} to X_{516} , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, a substituted or unsubstituted amino group, or a substituted or unsubstituted aryl group, provided R_{51} , R_{52} and X_{501} to X_{516} are not an anthryl group or a fluorenyl group.

20. The hydrocarbon compounds according to claim 19, wherein X_{505} is a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, or a substituted or unsubstituted aryl group.

21. The hydrocarbon compounds according to claim 19, wherein X_{501} , X_{504} , X_{506} and X_{509} are a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, or a linear, branched or cyclic alkoxy group.

22. Hydrocarbon compounds represented by the formula (6)



wherein R_{61} and R_{62} , independently from each other, represent a hydrogen atom, a linear, branched or cyclic alkyl group, a substituted or unsubstituted aryl group, or a substituted or unsubstituted aralkyl group, A_{61} represents a substituted or unsubstituted aryl group, and Z_{61} and Z_{62} , independently from each other, represent a hydrogen atom, a halogen atom, a linear, branched or cyclic alkyl group, a linear, branched or cyclic alkoxy group, or a substituted or unsubstituted aryl group.

23. Materials for an organic electroluminescent element according to any one of claims 1 to 22.

24. An organic electroluminescent element in which at least one layer containing at least one of the materials for the organic electroluminescent element according to claim 23 is held between a pair of electrodes.

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25. The organic electroluminescent element according to claim 24, wherein the layer containing the material for the organic electroluminescent element according to claim 23 is a luminescent layer.

5 26. The organic electroluminescent element according to claim 24 or 25, wherein the layer containing the material for the organic electroluminescent element according to claim 23 further contains a luminescent organic metal complex.

10 27. The organic electroluminescent element according to claim 24 or 25, wherein the layer containing the material for the organic electroluminescent element according to claim 23 further contains triarylamine derivatives.

28. The organic electroluminescent element according to any one of claims 24 to 27, wherein a hole injection transport layer is further provided between a pair of electrodes.

15 29. The organic electroluminescent element according to any one of claims 24 to 28, wherein an electron injection transport layer is further provided between a pair of electrodes.

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Figure 1

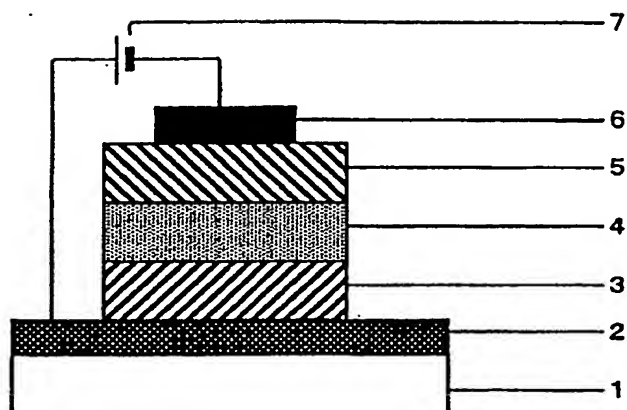


Figure 2

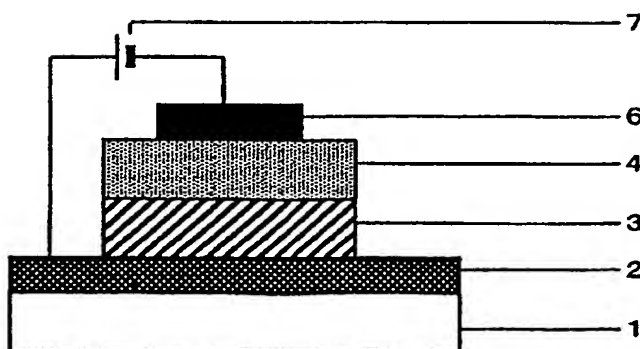


Figure 3

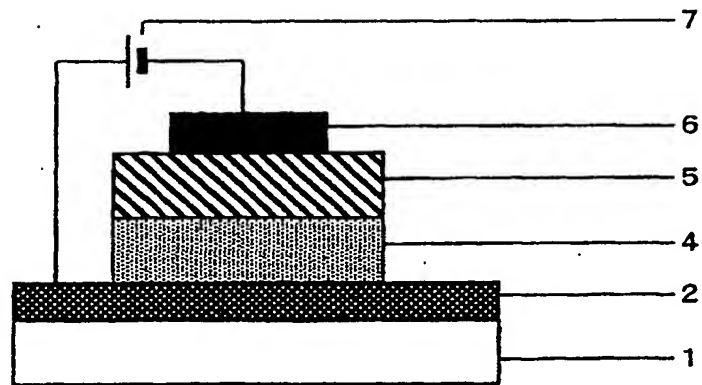


Figure 4

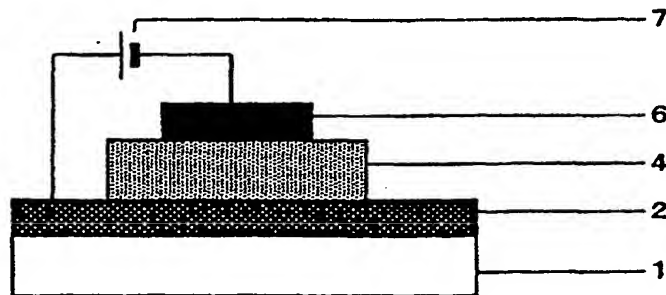


Figure 5

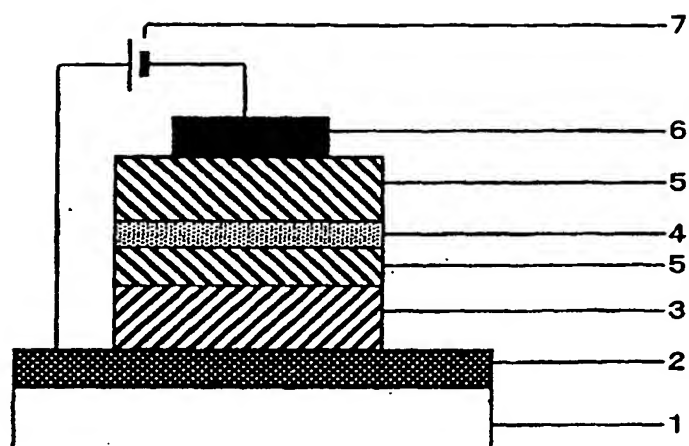


Figure 6

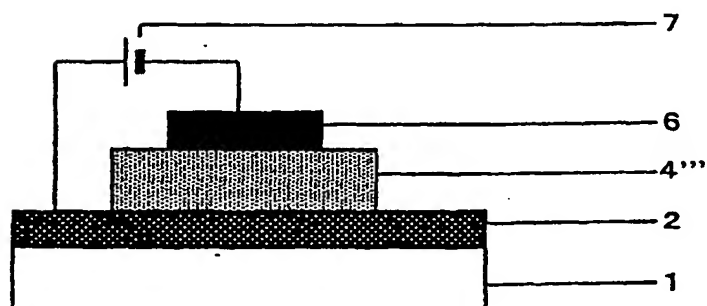


Figure 7

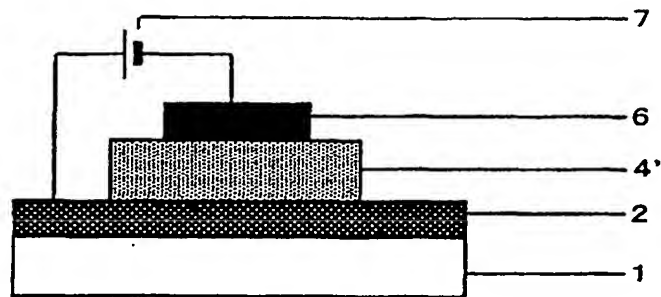
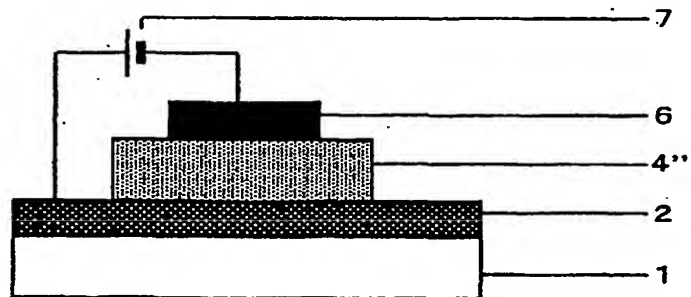


Figure 8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP01/06920

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ C07C13/58, 25/22, 43/235, 211/53, 211/61, C09K11/06, C07D213/16, 333/18, 215/04, H05B33/14		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) Int.Cl ⁷ C07C13/58, 25/22, 43/235, 211/53, 211/61, C09K11/06, C07D213/16, 333/18, 215/04, H05B33/14		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CAPLUS (STN), REGISTRY (STN)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 11-111460 A (Toyo Ink Manufacturing Co., Ltd.), 23 April, 1999 (23.04.99) (Family: none)	1-4, 6, 12, 15, 23-29 5, 7-11, 13-14, 16-22
X A	Weber, Edwin et al., "Versatile and convenient lattice hosts derived from singly bridged triarylmethane frameworks. X-ray crystal structures of three inclusion compound", J. Chem. Soc., Perkin Trans. 2, (1990), No.12, pages 2167 to 2177	1, 3-4, 10 2, 5-9, 11-29
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed		"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
Date of the actual completion of the international search 11 December, 2001 (11.12.01)		Date of mailing of the international search report 18 December, 2001 (18.12.01)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
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